

July 25, 1960

Aviation Week

and Space Technology

75 Cents

A McGraw-Hill Publication

**Checkout Unit
For Polaris
Aids Reliability**



Boom Operator's View of B-52G Refueling

SPECIAL REPORT:

USAF Studies Hypersonic Glider Shapes



NOW... PSI MICRO-DIODES PRICED THE SAME AS CONVENTIONAL DIODES

Silicon Micro Diodes (1/50 the size of conventional diodes) are now available at the same price as their larger counterparts. They include the electrical equivalents of several widely used types:

HIGH SPEED MESA COMPUTER DIODES—1N604—1N614 GENERAL PURPOSE COMPUTER DIODES—1N643—1N651—1N662 LOW LEAKAGE SILICON DIODES—1N457—1N458—1N459—and a new high voltage series to 1.2 kilovolts.

Additionally, Pacific Semiconductors, Inc. has recently introduced a series of Micro Transistors designed as companion components. These include electrical equivalents of transistor types 2N3686 and 2N3691.

RELIABILITY IS CONVENTIONAL DIODES

These Micro Diode types meet or exceed all environmental requirements of MIL-S-12000:

1. MOISTURE RESISTANCE: MIL-STD-200A, Method 105A
2. TEMPERATURE CYCLING: Ten 15 minute cycles—55°C to 100°C
3. THERMAL SHOCK: MIL-STD-200A, Method 107, test condition C (—55°C to 250°C)
4. CONSTANT ACCELERATION: More than 30,000 G

For details on life testing and reliability curves, write today for "Micro-Diode Reliability Study."

Pacific Semiconductors, Inc.

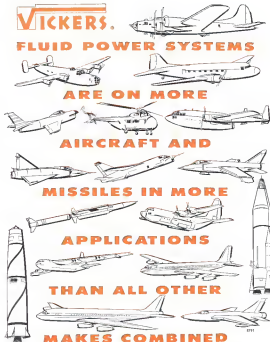


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Vickers Aircraft and Missile applications*

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Beyond All Others...



Here's Why Silastic Is Used In Man's Probes Into Space!

By going faster and farther into space the X-15 adds to our rapidly expanding knowledge about the elements of man and materials surviving the trip out—and back. That's why only proven materials are selected. One of these is Silastic® LS, the Dow Corning fluoroelastomer rubber that resists oils, fuels and solvents.

Engineers of Rocket Motors Division of Throck Chemical Corporation specified an accumulator diaphragm of Silastic LS for the X-15's XLR-60 engine. The accumulator provides oil at a constant pressure to the lobe of pump. Gaseous nitrogen under pressure is the source of stored energy, and is separated from LHV Hydrocarbon oil by the Silastic LS.

Here are diaphragm requirements the designers established as essential. An elastomer flexible hoop —80 to 300 F. (Silastic LS resists this flexibility from —80 to 300 F.); compatible with the fuels oil at low and elevated temperatures (Silastic LS has little swell or change in dimensions outdoors after immersion in easy hot oils, fuels and some hydrocarbon fuels); will not permeate fuel oil (Silastic LS has no plasticizer or additives which can permeate by leaching).

Silastic LS... the only elastomer to meet all these requirements... helps the X-15 go it alone on the dash to outer space.

Shown below is the XLR-60 rocket engine. The lobe of accumulator in the light weight type made possible by the diaphragm of Silastic LS... instead of the heavy, bulky piston type. Parts of Silastic can be engineered to meet your specific needs by your rubber laboratory.



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AVIATION CALENDAR

- Aug. 14-16th Civil Communications Symposium, Radio Station Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers, U. S. Army Signal Corps.
- Aug. 15- Future of Manned Manned, Air Force (Chandler Museum), Institute of the International Astronautical Federation, San Diego, Calif.
- Aug. 14-16th Annual Symposium and Exhibition, Society of Photographic Instrumentation Engineers, Anaheim Hotel, San Diego, Calif.
- Aug. 24-27th Annual U. S. National Meeting, Chicago, Ill. Sponsors: AIAA, ASEE, ASME, etc.
- Aug. 21-23rd Annual Meeting on Music and Rocket Technology, University of Connecticut, Storrs, Conn. Sponsors: U. S. Army, etc.
- Aug. 21-23rd Annual Meeting, American Astronautical Society, Chicago Hotel, Joffe, Wash.
- Aug. 22-23rd Pacific Coastal Meeting, American Institute of Aeronautics Engineers, El Cerrito, Calif. Sponsors: AIAA, etc.
- Aug. 24-27th Fourth National Heat Transfer Conference and Exhibit, 20th Annual Meeting, N. Y. S. Society of Chemical Engineers, American Society of Mechanical Engineers.
- Aug. 25-27th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm.
- Aug. 26-27th Fourth Annual Test Series Conference on Biological Effects of Micro-wave Radiation, New York University Post Graduate Medical School, N.Y. Medical Center, N.Y. Sponsors: AIAA, etc.
- Aug. 28-29th Second International Symposium on Science and Space Medicine, University of Toronto and Naval Medical Center, Canada, London, England.
- Aug. 28-29th Second International Symposium on Science and Space Medicine, University of Toronto and Naval Medical Center, Canada, London, England.

AVIATION WIRE AND SPACE TECHNOLOGY

July 25, 1950
Vol. 25, No. 4

Contains all the latest news in the field of aviation wire and space technology. Includes articles on the development of new materials, the use of new manufacturing techniques, and the latest in space technology. Also includes a section on the latest in space technology, including articles on the development of new materials, the use of new manufacturing techniques, and the latest in space technology.

Subscription information and contact details for the publisher, Lavelle Aircraft Corporation.



Photo courtesy of the Department of Aeronautics

aerospace Components for RVX and TIROS Projects by LAVELLE

Major successes in the nation's accelerated space vehicle and missile programs include precision sheet metal components made by Lavelle. Among these is the fabrication by Lavelle of the structure of the new U. S. earth-orbiting TIROS weather observation satellite produced for the National Aeronautics and Space Administration by the Aero-Electronics Products Division, RCA. An artist's view of TIROS in orbit is shown above.

Pictured also is the recovery of the first successful RVX re-entry vehicle after ICBM range flight. The aluminum alloy nose cone structure for this test was fabricated by Lavelle under sub-contract from the General Electric Company's Missile and Space Vehicle Department.

Some of the reasons why Lavelle has been selected to be a part of such dramatic projects are illustrated in a new brochure. Write for your copy.



Photo courtesy of the General Electric Co.

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For technical data on the new Cherrylock® "2000" Series rivets, write Cherry Rivet Division, Townsend Company, Box 2157-N, Santa Ana, Calif.

*Pat. Pending

CHERRY RIVET DIVISION

Townsend Company

In Canada: Permanent & Bulfinch Manufacturing Company Limited, Georgetown, Ontario

AVIATION CALENDAR

(Continued from page 5)

- Aug. 23-25-1968 Congress Engineering Conference, University of Colorado
- Aug. 23-26-Wireless Electronic Show & Convention, Los Angeles Memorial Sports Arena, Los Angeles, Calif.
- Aug. 25-Sept. 5-1968 National Air Rally, Municipal Airport, Chicago, Mass. Spots for National Aeronautics Assoc.
- Sept. 1-Symposium on Rocket and Solid Ion Acceleration, Society of Inertial Instrument Technology and Space Navigation Systems, London, England
- Sept. 4-5-Dublin, General Electric Avionics Show, Limerick Airport, Limerick, Ireland
- Sept. 4-11-1968 International Flying Display and Exhibition, Society of British Aircraft Manufacturers, Farnborough, Eng.
- Sept. 5-8-1968 Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Mass. Sponsored by American Society of Mechanical Engineers, American Institute of Electrical Engineers, Institute of Radio Engineers, American Institute of Chemical Engineers
- Sept. 8-9-1968 Engine and Operations Symposium, Aircraft Corp., Midvale, N. J.
- Sept. 12-14-1968 Annual General Meeting, IATA, Copenhagen, Denmark
- Sept. 12-16-Second International Congress, International Council of Hot Air Balloonists, Zurich, Switzerland
- Sept. 14-16-1968 Moscow, National Aeronautics Office, Moscow, U.S.S.R.
- Sept. 15-18-1968 Annual Meeting, Aeronautics, Chemical, and Space, Sheraton Park Hotel, Washington, D. C.
- Sept. 19-21-National Symposium on Space Electronics and Technology, Institute of Radio Engineers, Sheraton Hotel, Washington, D. C.
- Sept. 20-21-1968 Annual Meeting, Air Force, National Business Aviation Assn., Anaheim Hotel, Los Angeles, Calif.
- Sept. 21-23-National Convention and Assembly, American Society of Heating, Refrigerating and Air Conditioning Engineers, New York, N. Y.
- Sept. 21-23-1968 Annual Convention, International National Aviation Council, Harrogate Hotel, Harrogate, British Columbia
- Sept. 21-23-Space Power Systems Conference, American Nuclear Society, Milwaukee Hotel, Santa Monica, California (USAF, U. S. Army, U. S. Navy, NASA, AFSC)
- Oct. 1-5-1968 National Communications Symposium, Institute of Radio Engineers, U.S.S.R., M. T.
- Oct. 5-5-Second Annual Meeting, Institute of Radio Engineers, International Group on Nuclear Service Conference, Texas Compressor Oil Refiner National Laboratory
- Oct. 5-6-McDonnell McDonnell Conference on Air Logistics, Institute of the Aeronautical Sciences, Tulsa, Okla.
- Oct. 5-6-1968 International Air Traffic Control Conference and Fifth Annual Meeting of the Air Traffic Control Assn., Sheraton Palace Hotel, San Francisco
- Oct. 18-14-Security of Air Traffic, European National Aeronautics Meeting, Anaheim Hotel, Los Angeles, Calif.

New CJ805-23 Aft-Turboprop Engines Designed With Aeroquip High-Performance Products



Aeroquip 444 flange of Puller, 445 flange and Aeroquip control levered fitting body, installed by a General Electric employee on the CJ805-23 during production.

The CJ805-23 aft-turboprop engine represents a new peak in engineering achievement for General Electric. It is designed with the promise of greater fuel economy for commercial airliners in climbing and cruising, plus lower operating costs. High-performance Aeroquip products are specified for use on the fuel system of this new engine.

Aeroquip produces a complete range of fuel line products for top performance in aircraft and marine applications. These extensive product lines plus Aeroquip's engineering experience are available to help you solve any fuel system design and development problem. Mail coupon for complete information.



The 444 flange on Correll 440 equipped with the General Electric CJ805-23 engine, is one of the units by Aeroquip Airlines, Boeing, 747 and 747.

AEROQUIP HAS MANY PRODUCTS USED ON NEW CJ805-23 AND CORRELL 440



Aeroquip 444 flange of Puller and the CJ805-23 engine with Aeroquip 445 flange for the 444 flange.



Aeroquip 445 flange and the CJ805-23 engine with Aeroquip 445 flange for the 445 flange.



Aeroquip 445 flange and the CJ805-23 engine with Aeroquip 445 flange for the 445 flange.

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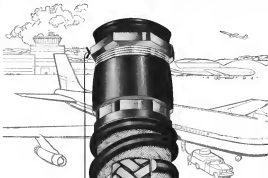
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For more information on this outstanding jet starter hose see your Thermoid Division distributor or write Thermoid Division, H. K. Porter Company, Inc., 200 Whiteland Road, Trenton 6, N.J.

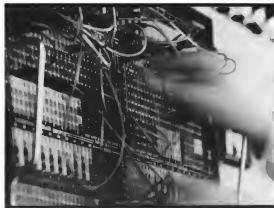
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THE SUCCESSFUL development of these new APM alloys suggests what can happen when Alcoa research is applied to defense projects. We always stand ready to take on Research and Development assignments of a similar nature. For more information on APM alloys or Alcoa's R&D capabilities, write: Aluminum Company of America, 2326-U Alcoa Building, Pittsburgh 23, Pa.



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satellite can
bring you live TV
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World-wide live TV, with no cable or radio relay costs, can develop from outer-space research by government and industry

Among the peaceful applications for scientific breakthroughs being made in the study of outer space is a communications satellite.

Using inflated plastic satellites, boosted toward orbit by the Air Force Thor rocket, a global TV network could be established. TV signals would bounce to satellite and back to your station, giving you a front-row seat at events anywhere in the world. Cost should be a fraction of coastal cables and microwave relays now used.

Feasibility of Thor for this purpose is based on its demonstrated reliability. With Douglas responsible for airframe fabrication and assembly and test of the entire system, Thor has helped launch 80% of all payload weight put into space by the U. S., is the key booster in the Air Force "Discoverer" series, launched the first nose cone recovered at KCHM range.

Thor is another product of the imagination, experience and skills which Douglas has gained in nearly 30 years of missile development.

Full-sized satellite, lifted like a pocket missile, would bounce out in orbit to an inexpensive TV relay station.

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Alloy	Working Pressure	Tensile Strength	Impact	Percent Elongation	Typical Reduction of Area
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%
2-25H	117,000 psi	131,000 psi	10 ft. 100 ft.	10.2%	24.8%

Properties shown are averages of 25 tests.



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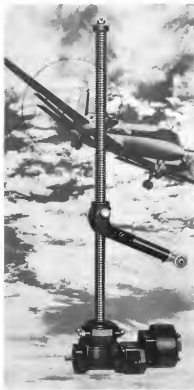
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WHO'S WHERE

In the Front Office

E. Clinton Towl, president, Grumman Aircraft Engineering Corp., Bethpage, N. Y., according to the late, Leon A. Swickard. Also William T. Schwaninger, chairman of the executive committee, and Elizabeth J. Evans, a vice president.

Harold Halpern, president, Wirtman Corp., Santa Monica, Calif. Mr. Halpern continues as president of Gen. and Holguard Inc., a subsidiary. Also Frederick M. Hensbrook, Jr., board chairman of Wirtman, succeeds Adm. Alan C. Kirk (USN, ret.) who is now chairman of the finance committee on Tindles Inc., Spring field, Mass.

Royal Lurie, president, Textron. The owner, New York N.Y., succeeded George W. Miller, now president and chief administrative officer of Textron, let. Also Joseph B. Gillmore, vice president and treasurer, and Charles K. Mills, vice president and assistant to the president of Textron, Rochester.

Frank E. Hedrick, executive vice president, Beech Aircraft Corp., Wichita, Kan., and James N. Lew, vice president/engi-

Bernard R. Gassett, vice president engineering and research, Local Electronics Corp., New York, N.Y.

Thomas C. Clark, a vice president, Houston Fuelco Corp., Los Angeles, Calif. Mr. Clark continues as general manager of the company's Houston Fuelco Division.

Thomas J. Carroll, vice president in charge of new products, Southside Inc.

W. L. Leadless has assigned as vice president-operations of Fitchell Engine & Airplane Corp., Hagerstown, Md.

Robert C. Newman, Jr., assistant administrator of the National Aeronautics and Space Administration, Washington, D. C.

NASA's Marshall Space Flight Center Huntsville, Ala., has announced the following appointments: **Craig Bart J. Shetty**, R., director of public information. For-

Elkay, deputy director of information, for M. Isaac, senior chief. Erich W. Neubert, associate deputy director for research and development. Dieter Claus replaces Mr.

Neelke doornik is director of the Centre's Systems Analysis and Modelling Division. Mrs. Sherraine Kneigt is deputy director of the Centre's Compliance and Control Division.

Honors and Elections:

John E. Serrano, a meteorologist for United Air Lines, has been awarded the Edgar S. George award for an "outstanding contribution toward the improvement of weather analysis and/or weather forecasting."

INDUSTRY OBSERVER

North American Aviation has secured an Air Force contract to study problems related to providing modern engines in the B-70 airplane. One objective is to determine what substitutions would need modification to operate in the radiation environment.

* Contract award is expected shortly for over-60 operational system for Jet Propulsion Laboratory's Goldenrod, Calif., testing facility. Some dozen firms, including Westinghouse, General Electric, International Telephone and Telegraph, Hughes and Calsonic Engineering, have bid. Facility's 40 kw. incandescent is to be boosted to 100 kw. within a year, and a 1,000 kw. installation is being considered.

• **Urean Carbons**, second largest U.S. chemical compound, is now taking an active interest in metal passivation work. DuPont's new patent control puts it almost to classified work, in the field. First it records intricate details of its own improvements in stainless, high-strength, propellants and solid propellants, together to polycarbonate and polybutadiene-acrylic and tries to obtain a new one.

► British Ministry of Aviation has ordered 30 more Folland Gnat turboprop trainers after accepting the tender sent aircraft to Royal Air Force's standard advanced trainer. Five of the 14 aircraft ordered for evaluation have been flown. Gnat, powered by the 4,210-hp-thrust Mark 100 Bristol Siddeley Orpheus engine, replaces the de Havilland Vampire T.11.

• **SEPR**, Pwack's most complex, is negotiating an agreement for solid rocket work with Thiokol Chemical Corp. believed to be similar in nature to the technical-commercial agreement for liquid rockets recently signed by SEPR and Rockwell (see p. 51). Until now SEPR, which is owned by two aircraft and four chemical companies, has left the solid propellant field to state-owned Service des Propulsoirs.

*Cost argument proposed by Strategic Air Command to show desirability of the B-50 weapon system estimates that a fleet of these bombers would cost the U.S. \$10 billion, but would force the Soviet Union to spend \$40 billion to strengthen its air defense system.

■ **Marquardt** is pushing development of hybrid rocket for ballistic missile boosters. Grand Central now provides Marquardt with solid propellant gains for this work, but may get direct competition from other companies, including Hercules Powder.

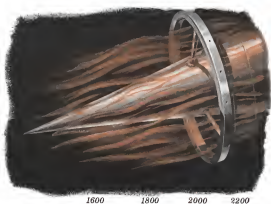
►Thirtieth-century break lay of the North American B-70 bomber can accommodate largest nuclear weapons existing or now planned. Break bay also can carry a wide variety of smaller nuclear weapons, making possible attack on more than 30 targets as a single mission. Multi-target capability is being provided through development of electronic countermeasures and reconnaissance pods. Break bay can carry its pods at once, some of these mounted.

► Harsco Powder Co. expects to sell Thakof reinforced plastic rocket tubes for Minuteman missile first stage. Production price is estimated at \$25,000 each, or approximately half the cost quoted for metal tubes.

• **Bitum's Arm & Steel** shoddy bins is scheduled to merge powered lift bins and mouth, traveling full range with a demand without. Unpowered drop bins have been covered out. **Boards** under test now are Mark 1. Bitum's Mark 2 V-boarder will carry the Mark 1A Blue Steel, with increased range and improved guidance system.

►Development engineering inspection of Meistrum pneumatic ballast control system is under way at Boeing Airplane Co.

*Rickettsiella Soviet marchus ship Shokalskiy (AW July 18, p. 23) was scheduled for a Pacific cruise after losing five astromological satellites on its Black Sea shakedown cruise. Rickettsi march 30 wk. altitude, study genome, temperature, and solar sailing effects.



Cutting back the Thermal Thicket

The great strength and high scaling resistance of Haynes alloys at temperatures of 2000+ deg. F. are providing long service life in the hottest areas of jet engines. Flame holders, flame stops and afterburners are some of the hot spots where the properties of Haynes high-temperature alloys are helping combat burnout, erosion, and stress in the jet, compressor, turbine, and rocket throats.

There are twelve HAYNES high-temperature alloys to choose from, formulated to handle virtually any heat condition. Among them, HAYNELL alloy X with remarkable resistance to oxidation up to 2000 deg. F. HAYNES alloy No. 25 that resists stresses, oxidation, and carburization up to 2000 deg. F. And HAYNELL alloy B-243, outstanding in the 1500 to 1750 deg. F. range. All are readily available.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation
Edison, Indiana



Solving high-temperature problems through research is part of Haynes' desire to provide complete metallurgical services. This cutaway photo is used to observe metals at 2000 deg. F.

Address inquiries to Haynes Stellite Company, 428 Lexington Avenue, New York 17, N. Y.

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Washington Roundup

Kennedy Defense Plans

Democratic presidential nominee Sen. John F. Kennedy may push for more defense money during the August session of Congress, even though the Fiscal 1961 defense bill already has been completed. If Kennedy were elected, this would provide the funds for him to expand the defense effort quickly in January.

Kennedy will meet with top advisers this week to discuss defense and other issues he may want to develop during the August session. The Democratic senator favors increasing the defense budget \$2.5 billion a year, and some of this increase could be voted next month.

National Aeronautics and Space Administration will brief industry this week on future needs in all its major areas. Industry is expected to send 1,200 to 1,500 representatives to the July 25-29 sessions, which NASA headquarters is running as an invitation only basis.

Readings will cover subjects ranging from advanced research in the practical question on how to do business with NASA. Advanced research discussions will cover general problems plus aerodynamics, light propulsion, space propulsion systems, power generation and structures and materials. Launch vehicle systems will cover orbital vehicles, Saturn advanced vehicles and nuclear rockets. Space research, satellite programs, lunar and planetary probes and manned space flight also will be discussed.

Higher than anticipated spending for military and space programs in the last six months failed to keep the federal budget from registering a surplus for Fiscal 1960. Defense Department spent \$255 million and NASA spent \$76 million more during the year than was estimated in January. But reductions in other item pools \$1 billion from total spending estimates and produced a \$1,568,000,000 surplus.

Seamans Joins NASA

Dr. Robert C. Seamans, Jr., will take over a management office that grew significantly in its first year of operation when he becomes assistant administrator of NASA on Sept. 1. The office has grown from its first office on June 1, 1959. In the period fiscal of 16 professionals and seven secretaries.

Richard E. Horner has held this number three job in the space agency, essentially a general manager's post, since it was created a year ago. He is leaving to join Northrop Corp.

Seamans is chief engineer of Radio Corporation of America's Missile Electronics and Controls Division and has been with RCA since 1935. He held tracking and project manager positions for 14 years at Massachusetts Institute of Technology, heading its Flight Control Laboratory from 1953 to 1955. Seamans served on National Advisory Committee for Aeronautics Technical committees from 1948 to 1949 and is a member of USARF Scientific Advisory Board.

Special House Appropriations Subcommittee established to study the Aircraft Nuclear Propulsion program has been dissolved. This group, composed of members of special subcommittees on public works and defense, was formed when this public works subcommittee cut \$15 million from the atomic energy budget for the ANP project. Appropriations committee later restored the funds, halting the closure out of the study.

Now the issue is whether a Defense Department ANP study due Oct. 8 will be limited by the House or the public works group. Rep. Milton E. Eisenhower of the Joint Atomic Energy Research and Development Subcommittee has discouraged approval of the Defense study will recommend cancellation of either the General Electric duct cycle engine project or the Pratt & Whitney rocket cycle approach.

Manned Aircraft Hopes

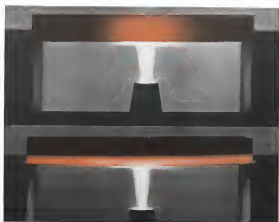
Defense Department and industry hope to get some face action on the future of manned research and the future course of the industry's manned aircraft work. Industry hopes to get a line on how much aircraft work will be available and what type it will be. Pentagon wants some realistic estimates of what such advanced aircraft work will cost.

Early study of manned vehicles from advanced VTOLs to Dyna-Soar will be announced at a joint Department of Defense-Air Force, Air Force Science conference. It will be held in San Diego Aug. 1-3. One prime topic will be Mach 6.0 hypersonic aircraft with a range of a fourth of the earth's circumference. Most consider this a necessary link between the X-15 and Dyna-Soar.

Conference will tackle the basic question when John Rubel, deputy director of defense research and engineering, discusses the economic choice for manned aircraft. Rubel will be the economic problem to researchers for fighting different types of war.

Services are expected to present a detailed review of future aircraft requirements as they now see them. NASA will discuss technical aircraft materials now and expected to be available to meet military requirements. Industry will estimate what can be accomplished with manned aircraft in the coming years.

—Washington Staff



HEAT from oxygen-rich flow goes through 0.31 in. thick slab of commercial graphite (top), while in 0.21 in. slab of pyrolytic graphite produced by High Temperature Materials, Inc. (bottom), it is distributed along layer planes.

Pyrolytic Graphite Studied for Re-Entry

Radiation heat shielding technique may save weight and improve re-entry velocities and accuracies.

By Michael Taylor

Extensive development work now under way on new graphite materials and structures may soon lead to radically new ballistic re-entry vehicles and rocket nozzles which work principally through radiation rather than ablation or heat storage.

New radiation heat shielding techniques could lead to significant savings in weight and improve re-entry velocities and accuracies. One scientist estimates that new graphite re-entry structures will weigh only one tenth as much as current ablation re-entry vehicles (AW July 18, p. 14), will come in on target six-fold faster, and will also be more accurate. In rocket nozzles and blunt bodies, new materials reportedly will also permit smaller nozzles in weight as well as the use of high oxygen propellants with high combustion temperatures and high axial suction.

Currently, most interest is focused on pyrolytic graphite (AW Dec. 7, p. 56), a highly accurate radiation shield. First re-entry applications of this material are expected to be in the rocket nozzles and re-entry vehicle of an improved 1,500 mi Polaris intercontinental range ballistic missile. Navy Special Projects Office, principal military sponsor of research and development on pyrolytic graphite, sees it as the prelude to establishing engineering collaboration programs for pyrolytic graphite material and structures with Lockheed (re-entry vehicle) and

Aermet (nozzle). First flight test of a pyrolytic graphite nozzle will probably take place on a Polaris AX-2 test vehicle (last and next sophisticated versions of current AX-1 test vehicle) in about 10 months. First flight test of PG re-entry structure will be somewhat later.

Navy scientists are generally highly enthusiastic about pyrolytic graphite and pyrolytic graphite-based materials. Results of research appeared in the Special Projects Office over the past two years, a Navy official says, now probably will allow development of the material for ballistic missile applications.

An Aerojet is interested in graphite generally for high temperature applications but is more interested about pyrolytic graphite in particular. Last month, Aerojet and Development Command awarded Mutual Carbon Co. a division of Union Carbide, a three-year \$42 million contract for research and development of graphite for nozzles

and space vehicle components. Both Aerojet and National Carbon feel it is too early to choose one, since there is no certainty as to which is particularly suitable for use in graphite cloth. At the same time, it is not necessary, adds that pyrolytic graphite will lead it even into Aerojet's Minuteman ICBM. All three Minuteman missile contractors—Thiokol, Aerojet, and Hercules—are known to have contracts out for work on pyrolytic graphite nozzles. It is also conceivable, but less likely, that pyrolytic graphite will find its way into an advanced Minuteman re-entry vehicle. Other possible applications for pyrolytic graphite are in lightweight, scratch-resistant shields for manned re-entry vehicles such as the Project Mercury capsule and its landing edge structure.

Three principal Navy contractors working on research and development of pyrolytic graphite are General Electric, High Temperature Materials, Inc., and Hercules. In addition to the Navy's Special Projects Office, these companies are doing pyrolytic graphite work for Aermet, Aerojet, Lockheed, General Dynamics, Thiokol, Hercules, Rockwell, and Thiokol.

Beyond visible pyrolytic graphite, the Navy contractors are working on slabs of pyrolytic graphite and nichols, pyrolytic graphite fibers and coatings. At least one company, High Temperature Materials, is experimenting with the application of pyrolytic graphite processing techniques to standard high temperature materials, from ceramic fiber to ceramic tiles, and at least one other, to that of graphite and at the same time a more oxidation resistant.

Oriented Graphite

Pyrolytic graphite is essentially a highly oriented graphite. Compared with commercial graphite which has much an orientation ratio of 5 to 10, it is more crystalline than that. It is also oriented perpendicular to the surface for every one crystal oriented parallel to the surface, pyrolytic graphite has, has orientation ratios from 100 to 1 to 1,000 to 1.

For the missile nose, the structure of pyrolytic graphite does present problems from its high thermal anisotropy, that is, its ability to conduct heat readily in one direction and block it in another. Thermal conductivity of pyrolytic graphite will run 50 to 1,000 times higher in a direction parallel to the surface, says a High Temperature Materials scientist, than in a direction perpendicular to the surface. At the same time, the material across the high reflection temperature of up to 6,000°.

Several advantages of pyrolytic graphite is more higher than the thermal

working it is impossible to transmit through a PG acoustically reflects the acoustic signals that would be required for data acquisition or steering. To get around this problem, HTM has developed a design which it says can achieve close to 100% transmission of sound and signals in a direction perpendicular to the surface. Now HTM does it and no work at all with bent horn and other methods with pyrolytic graphite.

In addition to topics of density and high temperature tensile strength, pyrolytic graphite is excited by its proximity with living organisms. One of the drawbacks is that poor radiation and erosion resistance that cannot handle more than four months in a vacuum (AW May 12, 1958, p. 52). But more perhaps than an other angle factor, it is pyrolytic graphite's thermal conductivity at high sublimation temperature and high thermal anisotropy that accounts for the high thermal conductivity. High thermal conductivity is a disadvantage. The important phenomenon has been aerodynamic heat transfer. But both types of heat transfer can, with drastic (density) velocity and decrease of the re-entry vehicle, and at high enough densities and velocities is where becomes the dominant form of heat transfer from the hot compressed gas ahead of the vehicle. However,

under certain conditions reentry is possible in which a body will suffer heat only as fast as it is cooled.

An important drawback here has been the fact that equilibrium temperatures for both a re-entry vehicle as well as the destruction temperatures of most materials. Current materials similar to those used in the Mark IV re-entry vehicle for the Titan for example start to melt around 3,200°. At this temperature, pyrolytic heat transfer is not too significant. But radiation may be a factor of 2 with heat rejection. Thus at 3,200°, the sublimation temperature of pyrolytic radiation heat transfer is enough to burn gases and more important, heat the gas at HTM scientist a Mark IV type of vehicle made of pyrolytic graphite would reach an equilibrium temperature well below it reached the sublimation temperature of the graphite. In this instance differential has the potential for increasing the re-entry velocity by further streamlining of the vehicle to solids.

Heat Diffused

Rated heat input per unit area is generally highest at the tip of the re-entry vehicle nose cone. Highly streamlined nose cone made of solid materials would decompose quickly in the case of pyrolytic graphite, however, the material's thermal anisotropy would serve to spread the heat over the surface thereby lowering the entire re-entry vehicle into a radiating body. At the same time, a Materials Industries point out, this characteristic serves to block the heat going through the PG heat shield.

It is possible, according to pyrolytic



PYROLYTIC GRAPHITE (shown on one side in laboratory a variety of shapes such as those produced by High Temperature Materials, Inc. What appears to be first in some of the structures are simply oriented grains.

graphite producers, to obtain a new prototype drop of approximately 4000 across a price of 20 cents per 100 lbs. back to the cost of 10 cents, indicates the means that the metal bipolar structures can be made from the lightweight but relatively low temperature materials such as tungsten and molybdenum. In the case of metal catalyst, it meant that the heavy metal beds took new work with refractory liners can be discarded.

Tests indicate, it is reported, that positive graphite stacks exhibit high resistance to erosion and oxidation in gradients of the propellant used in true pulse operation. The high velocity temperature of PG motors also tends to reduce the formation of oxide deposits from propellant into liquid metal contacts. Even more significant, it is observed, is the fact that the PG engine modulates heat back into the combustion system of being it escape into a hot jet. Also, since positive graphite does not ablate or erode significantly, the oxide reactions in its exposed design. This factor is even more critical in refractory applications where changing configurations are used to maintain reliability and less of erosion.

Positive graphite is such a hot new, but the ability to produce the material in large quantities is not. One method now being used to produce the material consists of running hydrocarbon gas such as methane or natural gas through a reformer furnace at temperatures ranging from 1,800 to 2,500°C. As the gas flows through the furnace, it reacts with oxygen to form hydrogen, which is then used in the reformer. Hydrogen and metal impurities are pulled out through.

The material, generally made of silicon carbide, may be made in the form of a stacked structure. If it is not to be used in the stacked form, it is broken down into the positive graphite pieces which are then sintered and either used as it is or a diffusion to a different substrate.

Ironing or bonding positive graphite to other materials is one of a number of problems PG producers are now trying to solve. Another problem is that a positive graphite structure could cause, it tends to shrink away in some direction than others, inducing stresses in the material. Problems such as High Temperature Materials are being in a variety of designs and other persons consider so that they can eliminate positive graphite structures in such a way that these stresses are not affect the other properties. In some cases, the materials, they are also getting the initial design of end products such as solid rocket motors "to ensure that positive graphite's full potential is utilized."

Perhaps the most critical problem at this time is that of quality control in

massive and/or superconductivity PG problems are still working on the problem of dissolving properties such as grain size and structure. Over the years, the project's progress is completely closed off, the problem becomes one of developing non-destructive inspection techniques to measure these properties. Another important consideration is, of course, an adequate control of process parameters to ensure that a given set of properties can be obtained upon demand.

Handling also is somewhat of a problem with positive graphite structures, which are inherently brittle at room temperature when compared with metal structures. High Temperature Materials does not consider that a problem, and says that the material is as strong as it is required. In fact, large PG production does consider one of these problems unsolvable and fears that they could go into production of full scale war costs and thereby in a matter of months.

The leading force, then, is in the time it will take that distance for ground and flight evaluation.

Defense Policy Council Airs R&D Management

Washington—Defense research and development (R&D) management problems in a broad effort to coordinate the 54 billion research, development, test and evaluation program. This is the result of the first major problem conference sponsored by the Defense Research and Engineering Policy Council held recently at Ft. Monmouth, N.J. (AW Week 11, p. 25).

At the conference, military service research chiefs with their civilian counterparts, program managers used a variety of general management problems in the growing research and development effort. Discussions ranged from the fields of military-industry communications to test facilities on what the units they research now does. Dr. Herbert P. York, director of defense research and engineering, and chairman of the conference.

York, who stated that long-term objectives, establish operating methods and set a defense research and development policy.

The military services agreed that specific service requirements dictate defense research by each. An organization would be awarded. This specifically sets the framework for each service in its own and developing research under broad guidelines from York.

There were other major questions discussed.

System of using Air Force and Navy defense services for Army research

plans difficult communications problems with industry. Different requirements for the same research results in management which are different. Over the years, the project's progress is completely closed off, the problem becomes one of developing non-destructive inspection techniques to measure these properties. Another important consideration is, of course, an adequate control of process parameters to ensure that a given set of properties can be obtained upon demand.

York's effort is continuing scientific influence as military direction by involving on more adequate (small) analysis of patterns, but the service and by maintaining close liaison with the Joint Chiefs of Staff.

Government laboratories should not compete with industry, only play a supporting role in the field. The service should be able to do production tasks, except in special circumstances, beyond the initial prototype.

Individual service management should be improved, but the service and outgrowth, but also focus identification of non-producible research and development efforts.

Government laboratory problems include many lines of program planning, often to complete lead time, lack of support for research and development construction, rejection of personnel, and changes during the contract cycle. The service should be able to do production tasks, except in special circumstances, beyond the initial prototype.

There major phases in the life cycle of a weapon system are development, design and service use. The service should be able to do production tasks, except in special circumstances, beyond the initial prototype.

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Boeing Cancels Report at ARS Meeting

Columbus, Ohio—A report on a preliminary review claimed to significantly correct the specific impeller problems of liquid hydrogen and liquid helium was cancelled by Boeing Aerospace Co. at the last meeting of the American Rocket Society (ARS) Convention and Liquid Rocket Conference last week.

The report on "The Ultimate Cryogenic Rocket," prepared by five Boeing researchers, had been accepted and accepted by the American Rocket Society (ARS) Royal society committee, and passed of specialists in this field from several companies. The report was a major presentation at the conference and was also scheduled for an International Astronautical Federation meeting in Stockholm, Aug. 15-20. Copies were sent to Europe by air.

The specific impeller problems of liquid hydrogen and liquid helium had been regarded as the ultimate in rocket design problems. The report, which was the last major report of the committee, was cancelled by Boeing Aerospace Co. at the last meeting of the American Rocket Society (ARS) Convention and Liquid Rocket Conference last week.

The report was regarded as highly controversial by most of those who were familiar with its contents but this was one of the main reasons the conference committee decided to present it. At an annual meeting, the committee had scheduled it for a complete review of its own so that there could be complete review for discussion.

Multi-Component System

The project reportedly developed a two-pellet system believed to be a multi-component system consisting of three and possibly four different components. The system was to be used in a rocket engine, for example, of a mixture of hydrogen and helium fuels obtained by a combination of liquid helium and ozone.

Individual tests were carried out among these persons planning to be finished with work in this particular area. Some of it was responsible to advance this performance, others and it was then critically possible on paper but that such systems could never work, as a rocket engine. Many had the authors must have made mistakes in their calculations, and a few people, including one of the authors, said they felt that the Boeing group had actually announced what it had and it had. There was general disappointment that the company had presented the report from Boeing for open discussion.

There was also a widespread feeling

of dissatisfaction among those attending the meeting with the large amount of what they considered marginal material that was allowed to be presented at the conference. Of the approximately 30 papers that were given at the conference, only one was supposed to go into the final program, a significant indication of the quality of the material presented at a given session.

A number of people such as Linwood W. Smith, chief of power systems at North American's Columbus Division and a conference technical speaker, criticized the situation in part by the ARS committee. The report was a major presentation at the conference and was also scheduled for an International Astronautical Federation meeting in Stockholm, Aug. 15-20. Copies were sent to Europe by air.

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Top-Off Operation

In the top-off report, the report is stated with a liquid propellant rocket engine. The report was a major presentation at the conference and was also scheduled for an International Astronautical Federation meeting in Stockholm, Aug. 15-20. Copies were sent to Europe by air.

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with a sophisticated gas generator system with regard to hardware and required operating functions. Housatonic reported, however, that a solution of approximately 60% in potential problems were not be achieved through use of the top-off device, a significant indication of the quality of the material presented at a given session.

At the same time, he pointed out, the preference of the top-off is much comparable to that of a non-catalytic engine.

In the current type of liquid propellant gas generator systems, fuel and oxidizer are injected into the combustion chamber and then the gas is used to produce the hot gas required to power the turbine that drives the propellant pumps. Both systems require precise fueling, sequencing, ignition, injection and flow control.

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GAO Report Highlights Space Competition

By Evert Clark

Washington—High-speed space competition that has made major advances in development contracting was emphasized again last week by a Congressional Accounting Office investigation of the choice of Douglas Aircraft Co. to build the forward stage vehicle for the Saturn space vehicle.

This was the fourth since National Aeronautics and Space Administration development programs to come under Congressional review, since NASA was created last two years ago. Others are the F-1 engine, the Mercury capsule and the 700,000 lb thrust engines engine contract. Since the Saturn program is the most important aerospace competition held to date by the space agency, the firm, faced with a declining number of military aircraft and missile contracts, awarded NASA's bid for both. Then selected 10 large aerospace companies and the Chrysler Corp., which had built the Jupiter intermediate range missile.

Stage Combinations

The Saturn stage, designated S-IV has an experience beyond the fact that it is the first large rocket aerospace development to be awarded to NASA. Saturn is to have two and possibly six different stages, to be used in a number of combinations. The first stage is being developed and assembled by NASA's Marshall Space Flight Center, at Huntsville, Ala., at least through the first 12 or 14 years. Saturn stages are considered from the boosters up, and the fifth stage or S-V, which is being developed by General, since it is considered the delta-Centaur vehicle.

The three intermediate stages and a possible sixth stage, therefore are the only ones to be developed by private industry under new contracts. An Arizona-Wash. contract ends this year (AW No. 15, p. 26) Saturn is expected to be a key vehicle in the nation's exploration of space, and building for all phases of its development will be hard fought. Saturn may play a large role in developing which competition will remain in the space development picture as the future.

Chrysler hoped it had an advantage in the competition, held last spring, because it had worked out a deal with Army bases at Marshall on the Redstone and Jupiter missiles and on Saturn's S-IV stage. General, then developing the S-V, signed hydrogen stage in this competition. Chrysler then gave it an advantage because stages two, three, four and the possible sixth

stage will all be hydrogen-fueled. All the companies involved hoped that the winner of the S-IV stage would automatically gain an advantage for the first when NASA opens bidding on stages two and three which will use the larger 200,000 lb thrust hydrogen engine.

An NASA technical evaluation committee, a business evaluation committee and a source selection board reviewed the bidding last April. Centaur was awarded to Aero-General, Douglas and North American and then North American was selected.

On Apr. 19, the source selection board issued a presentation to NASA Administrator W. Keith Garrison. General subsequently expanded that bid included the chronological steps taken in the evaluation process, its technical and business evaluation data in great detail and the board's analysis of that data. Therefore I selected the Douglas Aircraft Co. bid.

General interest that had preceded the selection of Douglas and the elements that followed from them prompted the House Committee on Science and Astronautics—among other congressional groups—to investigate.

General stated the following four reasons in being "among the candidates" influencing his choice:

• **Technical competence.** "The work of Douglas and General," said the unit, as revealed in their proposals. General had "a tight edge" that "did not seem to us to be overblown." General and the Douglas proposal, in some ways, seemed more realistic. General's, the other factor being going to General as the business community would want to advance only that attention to control of the details of operations was lacking. In the course of negotiations of the contract, order of their shortcomings would be corrected in all probability. General's work on Centaur was better than that in a tight edge in the technical competition.

• **Competition.** Considerable importance must be given to a consideration of the desirability of at least limited competition as we start off this new technology," General said. "Should it, it might well be the case that subsequent competitors for the other stages of Saturn would become quite qualified, as they had been in this field, to compete and should be awarded unless substantially superior results would be achieved or unnecessary complicated management arrangements are set up."

An examination of these factors produced a negative result—that is, no firm

portant cost or management problems are expected to arise if a second industrial organization enters the field," General concluded. "Indeed, some benefits may well accrue. Reconsidering the technical and management problems in the development of the hydrogen vehicle technology is the best national interest."

NASA appears to follow this philosophy in regarding development of the 200,000 lb thrust hydrogen engine to Rockwell rather than to Pratt & Whitney, which was developing the 110,000-100,000 lb thrust hydrogen engine for the fourth and fifth Saturn stages.

With regard to General's statement on costs, General bid \$98,300,000 and Douglas \$64,000,000, estimates of cost for the S-IV phase differed by \$5-4 million.

• **Indefiniteness.** Both Douglas and General are primary Air Force contractors, but USFV issued NASA that the Saturn work would not interfere with ongoing or planned Air Force programs. General said USFV offered assistance that USFV was available in both organizations—perhaps a bit more completely in Douglas, but adequate in General.

• **Value of business.** General's contract with General (S-V) comes in larger than production business for that company since S-V will be used both by Saturn and Atlas—in that, too, both because one of the "work horses" of the space program in both military and non-military activities," General said. "Thus, loss of the S-IV contract has some positive factors in the influence of competition then directed towards the S-V stage, of significant amounts of ongoing business. Both operations will continue to be healthy and not necessarily stressed to achieve competition."

Interest in Chrysler

Although General's contract deal with the relative positions of Douglas and General, the space committee will want to at least consider the position, since Chrysler had proposed building a plant near the Saturn launching site at Cape Canaveral, Fla.

General's comments dealt with the relative positions of Douglas and General, but the space committee added two of its three "interests of interest" to Chrysler's intention in asking the Government Accounting Office to study the Chrysler bid.

Chrysler had proposed building a plant on a 1,000-acre site at North Merritt Island, 15 miles from the Saturn launching pads, if it won the award.

The firm also, as the committee told GAO, "that had had knowledge of the cost of the second stage," and was not



Westland Westminster Fuselage Enclosed

Westland Westminster turboprop-powered transport fuselage, long fuselage, with an auxiliary structure exposed (AW No. 15, p. 96), is shown with the fuselage closed over its temporary structure. Historical evidence is new. Below is a first look at the first, but with a visible view from the side (AW No. 15, p. 96).

to be built with Chrysler's own funds in the subcommittee's interest. It was to be an aircraft and state-of-the-art facility, jointly financed, and including a state-of-the-art and other state-of-the-art facilities.

Although the GAO report does not mention this, General was questioned on Capitol Hill about his choice shortly after the Douglas award, about as a result of unpopularity in the Florida and Michigan congressional delegations. Chrysler had proposed use of the American, Chrysler-owned, Michigan Chrysler Motor Plant at Detroit for Douglas, manufacturer and assembly work. Michigan's unemployment rate and Chrysler's declining aircraft work influenced the finding in Congress about Chrysler's loss of the contract.

The Michigan plant was being planned by Chrysler's aircraft division on the site that Chrysler used for its operations on Capitol Hill. Among the firm he offered in discussion of the choice was that Chrysler had been awarded the top job in the technical ratings. Still another factor, as mentioned by the GAO report but not mentioned by Chrysler's statement, was the fact that the nation's largest helicopter production plant is located at West Palm Beach, Fla., only 200 miles south of Chrysler's proposed assembly and state-of-the-art site.

Chrysler, according to the GAO, had estimated that \$2-4,000,000 would be needed for government-owned equipment. Of this, \$2,817,924 would have been applicable to the assembly and test facility. To reduce funding requests, Chrysler proposed to transfer gas

crucial-owned facilities, tools and other equipment from the Detroit plant to the new government building. Funding required from \$2,817,924 to \$1,715,640.

An American Chrysler proposal to build the new facility on the Tennessee River near the Marshall Center in Alabama, where ships could go for construction and starting to Saturn's first stage before they go to the launch site—was rejected by the business community which had feared the Florida site was "selected and optimized for this program," according to GAO.

The other two aspects which GAO was asked to investigate were:

• **Effectiveness of selecting a contractor whose product will have to be shipped an estimated 10,000 miles from its plant in California to the Cape Canaveral launching site.** GAO found that transportation plans in all cases were acceptable in the business evaluation committee from the standpoint of time required to deliver the ship from there to Alabama.

GAO also found that the source selection board had that confidence of the technical proposal should be the dominant factor in choosing top plant contractors for final construction, that only 11 plants had been offered to transportation cost of 208 possible points in the technical evaluation committee's rating. If 11 points could not have affected aircraft shippings of one order because of the poor quality of the facility and that 28 of the top three contractors had West Coast plants in that transportation from California was not a factor in selection of Douglas.

Transportation costs to Huntsville

do not appear to be a significant part of total development cost. GAO and Contractor estimates for transportation cost and total development cost, excluding tax, were: General, \$754,000 out of \$19,265,000; Douglas, \$433,000 out of \$64,000,000; North American, \$275,000 out of \$64,390,000; and Chrysler, \$545,000 out of \$41,449,000.

• An indication to Chrysler's statement that developing the substantial loss in hydrogen technology "played an important part in developing gas" and that "the contractor might have been selected if it had not been for this consideration."

GAO replied that "it seems reasonable to reveal" from General's statement that the consideration of hydrogen technology was "played an important part in developing gas" and that "the contractor might have been selected if it had not been for this consideration."

The House committee under Chairman Orrin Robertson (D-Ill.) has paid considerable attention to NASA's award of the Lincoln 10 thrust F-1 engine contract to NASA's General Dynamics. The contract and the selection of Rockwell to develop the 200,000 lb thrust hydrogen engine. The report has been issued on the latter. The committee has suggested GAO's report on the selection of the manufacturer of NASA's Vega space vehicle program.

The Senate Aeronautics and Space Sciences Committee also has kept a critical eye on the contract. General's NASA proposal had that this critical conclusion is not warranted and that some attention might better be turned to procurement practices at other state-of-the-art agencies.

Russians Assembling Large Hydrofoil Boat

Moscow—Khrushchev's statement that the Soviet Union's largest hydrofoil boat, the 100 passenger Spatnik, which will have a top speed of 60 mph, is being assembled at Komsomolsk-on-Amur.

Regular passenger service with a diesel motor is expected to begin in a year on the Soviet coast. A Khrushchev has begun scheduled service between Leningrad and Komsomolsk-on-Amur. A 150-passenger Soviet hydrofoil made its first Moscow-Gorki run last July and later will be merged to Gorki-Kirovskiy, operations on the Volga River (AW No. 15, p. 117).

Near 300 "hydrofoil" "Roadster" each capable of carrying 60 passengers, are expected to be in regular operation on the Volga and reach large Siberian cities like Leningrad, Krasnodar and Irkutsk by the end of the year.

4

French Five-Year Military Plan Calls for Nuclear Strike Force

Paris—The French government, after months of debate and delay, finally has published its five-year military program which provides for the development of an independent nuclear strike force.

General outline of the program contains nothing startlingly new. Military thinking behind the plan reveals the development of an independent nuclear strike force, has been the major theme of the French government for several years. However, the plan does reveal for the first time specific amounts which the French plan to spend in various military categories.

The five-year plan, which starts from January 1968, to January, 1973 is based on fulfilling three basic military missions:

- There are:
- Defend French national interests
- Meet special defense missions in Africa and elsewhere in the French community
- Meet French commitments within NATO

To meet the first mission, the French plan to spend some \$6,252 billion over seven years, plus the coming five years. The published five-year plan, however, is concerned only with major projects which, because of their long lead time, have to be planned years in advance. That is, the published plan deals with major programs which will cost \$2,518 billion over the coming five years.

Three major five-year defense projects are specified in the following categories:

- **Aircraft:** Fifty Dassault Mirage IV strike bombers at a total cost of \$208 million. Two hundred and seventy air force tactical fighters and interceptors at a total cost of \$154 million. Seven hundred training aircraft at a total cost of \$112 million. Eighty air force light transport aircraft at a total cost of \$35 million.
- **Fifty rotary aircraft:** Fifty helicopters at a total cost of \$38 million.
- **Twenty-seven Breguet ASW (Anti-Submarine aircraft)** at a total cost of \$93 million. Two hundred and twenty helicopters for all three services at a total cost of \$62 million.

In addition to these aircraft orders, some of which already have been placed, the government will spend on its three main categories \$7.5 billion on nuclear strike force (major part will be spent in the defense research and development ASW) section. Thus over the next five years France will be spending a total of \$883 million on major aircraft projects.

• **Nuclear weapons and missiles:** Total of \$880 million will be spent on research and development of nuclear weapons including construction of an

atomic propulsion plant. Total of \$75 million will be spent on French participation in the NATO nuclear independent missile program. Total of \$174 million will be spent over the next five years in developing a French intermediate range ballistic missile.

- **Naval vessels:** Total of \$187 million will be used in financing construction of three missile-launching cruisers while \$61 million will be spent on construction of three submarines, one being a nuclear powered.

- **Army combat vehicles:** Total of \$300 million will be spent over the coming five years for purchase of combat vehicles and tanks.

About 95% of the five-year plan is taken up with development of France's nuclear strike force. This force—based in Mirage IV bombers—should be operational by the time the plan runs out in 1973. Some critics, however, already are complaining that by 1967 air strike force based on aircraft will be so small, that the \$230 million committed for the Mirage IV will be wasted money. The program, possibly, will be further used when the five-year plan comes up for debate before the assembly early next fall.

New Group Will Review Company Program Cost

Washington—Defense Department has formed a new Armed Services Committee. Charged with the task of reviewing and recommending independent research and development projects and recommending the extent to which they should be supported by Defense Department. The committee will also be authorized to advise the defense plan on matters of independent type projects.

The action is a direct outgrowth of recent revisions to Section 14 of the Armed Services Committee. The committee will differentiate between research and development for cost reimbursement and research and development for independent type projects.

Competition-oriented research and development programs meet the Defense Department's criteria of "independent research" in terms of type and materials, relative to previous company effort. A more cost-oriented research will be applied only to company-sponsored development programs in that they must be related to product lines for which the company has government contracts.

Where a contractor does business

with several military departments one will be named to act as joint agent (sponsor) for all departments in negotiation on cost accountability of value-oriented research and development programs.

Upon request of the sponsor department, the new review team Armed Services Research Specialists Committee (ASRSC) will review a contractor's proposed independent research and development projects to determine whether individual projects are suitable classified as research in development, and will recommend the extent to which it believes such should be supported as an allowable item of expense.

Committee also will indicate whether proposed independent development effort is being adequately related to existing government product line and whether it should be supported by the Defense Department. Where a contractor does not engage in production the committee will determine whether a proposed R&D project falls within its field of office under existing government research and development contracts.

Cooperation long business with more than one department, and asking for cost reimbursement for independent R&D, may be required to submit proposals describing each proposed project and its estimated cost. Research will be submitted to the sponsor department before the start of contract's fiscal year or within the first 90 days of the period.

The Armed Services Research Specialists Committee is headed by H. E. Christman, Director of Chief of Naval Material. Other members include: W. H. Foster, Office of Director of Defense Research and Engineering; D. A. Wines, Office of Chief of Army Research and Development; J. F. Sargent, Army Dept.; Chief of Staff for Logistics; Dr. F. J. Weyl, Office of Chief of Research and Engineering; Office of Assistant Secretary of Defense and Development Command; D. R. Robinson, Air Material Command.

Sikorsky Workers Ask NLRB Election

Probability of any negotiation between Chrysler Aircraft Co. and the United Aircraft Workers in a recent strike at United's Connecticut plants waspounded early at Stamford Division March 3, 1968. Workers petitioned the National Labor Relations Board for an election to determine a bargaining agent.

Indemnities for that which it is determined by secret ballot, considered by the NLRB, that the UAW no longer represents a majority of the workers. Area possibility for collusion

of negotiation bogged down with the issue pending determination of last year's general election, otherwise said.

Meanwhile, talks between labor national union of Machinists and United negotiators, involving workers at Pratt & Whitney's East Hartford and Middletown plants and at Hamilton Standard at Windsor Locks, seemed after a two-month hiatus.

United told it now has 23,539 production workers on the job, net of a total of 18,000. On a year-hour basis, the company told production now is 95% of normal.

Meanwhile, the month-long strike against Lockheed's Missile and Space Division by the IAM ended when workers accepted a two-year contract calling for a four cent per hour pay raise this year and another three cents next year. Other benefits include a severance payment of \$150 for each year of seniority, up to a maximum of \$500.

Lockheed's California Division which is involved in the strike, had not yet reached a settlement, but officials were negotiating one late last week. There are no strikes in progress at California Division locations.

At Boeing Aircraft Co., IAM members were scheduled to vote but were asked to vote on a new proposal involving Seattle and Wichita, Kan., facilities. Package is estimated at a 35 cents per hour raise (AW Feb 15, p. 27).

A strike at Avco-General, called for last Monday, was postponed when company and the IAM reached a tentative agreement, which was not disclosed pending membership talks at Santa Ana and Anaheim, Calif. Wages are the primary issue.

Tentative agreement also has been reached between the IAM and Rolls Royce at its Riverside and Cleveland, Ohio, plants. Negotiations called for a four cent hourly pay raise this year, three cents next year.

At Ft. Worth, Tex., representatives of General Electric and the IAM announced before the contract was signed that they were considering a new proposal to be considered by the NLRB. The proposal was to be considered by the NLRB on Feb 6.

Navy Cancels Corvus Development Project

Washington—Navy halted Texaco's Corvus missile development program this week and the company began to re-evaluate its position and laying off employees connected with the canceled project.

Navy and it cancelled Corvus because review of Navy programs indicated it would be better to shift development



Bell HU-1A Shows Missile Firepower

tactical capability of anti-aircrafting Bell HU-1A B-10 powered Army helicopter in a demonstration in this photo showing the Apache King No. 18 wing-mounted missile while away on the West Coast. The missile was assessed as such as they are likely to be used, pending clearance over issues during a test of the helicopter. HU-1A also carries an M16 (AW Mar. 7, p. 16).

to "weapon systems offering a wider scope of employment." Navy did not say when it will start the work planned for Corvus.

Corvus was an air-launched, solid-powered missile designed to home on enemy radar installations. It had a range of more than 100 miles and had been first fired at the Naval Missile Center, Ft. Meigs, Calif., from attack aircraft. It was under development by Texaco Electronics & Systems Co., a subsidiary of the new Lang Research Electronics, Inc., located in a strip between Texaco Aircraft Corp. and Lang Aircraft Electronics.

Texaco had 200 employees working directly on the program, and further demands are expected. Subcontractors involved in the development on Texaco's Reaction Motors Division, packaged liquid motor engine, W. L. Smith and Texas Instruments, guided air components. Whittaker Corp., shipping containers; Heston-Morse Associates, launchers; Emerson Research Laboratories, target detectors; Balco Electronics and Development Laboratories, worked solid and moving components; and Talcott Engineering Co., inventory system.

Navy estimates the Corvus program cost at \$40 million before it was canceled. No new funds were allocated for Corvus in the Fiscal 1951 budget, and the Navy apparently decided not to try to squeeze more money from other programs to continue developing Corvus. Estimated cost of completing development and procurement of the missile was \$40 million.

The \$80 million cost estimate of the canceled program was very after the Navy, which estimates costs and determines whether any funds committed might be recoverable. Executive Vice President Clyde Skorn and the company will submit a program to the Navy to show how much investment in the hardware and inventory on hand.

News Digest

Civil Airmanhood Road and last week that means that Pan American World Airways was attempting to give its first domestic route through control of National Airlines was the reason for the Board's rejection last April of a Pan Am-NAA financial stock exchange and option agreement.

Edward H. Hinesman, vice president of Douglas Aircraft Co., Inc., in accept an undisclosed position in industry, but was a technical consultant.

Air Force transferred ballistic missile site activation from Air Research and Development Command to Air Western Command to separate this function from development work, and named Maj Gen Thomas P. Gerety as chief of AMIC's Ballistic Missile Center Group. Gen. Don Campbell remains in Gerety's deputy.

General Electric Co. last week announced F. Shaw, vice president engineering of its I. I. Kaser Co., general manager of the Aircraft Nuclear Propulsion Department and shifted the department to an Aircraft Research Division. Shaw was director of security for the Manhattan Engineering District in 1946, then moved to the Atomic Energy Commission's Hartford Plutonium Works. From 1955 to 1957 he was assistant general manager-conducting at AEC headquarters.

North American Aviation's net income for the nine-month period ending June 30 was \$16,526,000 after a \$17,070,000 federal tax payment, compared with a net income of \$21,941,000 for a similar period a year ago. Sales were \$217,445,180, against \$193,794,844 last year.



SWISSAIR's first of three Douglas DC-6s made 13 round trips between New York and Switzerland during first month of operation.

Swissair, SAS Cooperate on Jet Support

By Cecil Beveline

Zurich-Swissair and Scandinavian Airlines System are jointly working a tightly knit maintenance and training program designed to permit the two carriers to operate the operation of these different jet transport types that can cover all but the shortest stage lengths of their respective route structures.

Parts of the plan is an interlocking "jet pool" agreement covering two of the three types involved combined with a close liaison program both within and beyond the framework of a co-operation contract that provides for prospective spare and engine pools for the Douglas DC-6B (AW July 4 p. 45). Here is how the plan which effectively forms a multi-national Air Union—mode.

Swissair is moving from Model 3 Jet Caravelles into SAS for flights over actively short stage lengths of 400 miles. All their aircraft are scheduled to be operating over Swissair routes within Europe and to the Middle East by early August. Although legally purchased from SAS and under Swissair's flag, SAS has an option to re-allocate the aircraft four years after their delivery to Swissair if it desires. Major maintenance, spare training and personnel of most of the spare parts needed for the Swissair Caravelles are to be supplied by SAS.

SAS, beginning in April, 1961, is scheduled to receive two of seven all-weather versions of the sub-sonic Conquest 400 medium-range transport

in order by Swissair, complementing their own two orders of last year for directly spare parts provisioning major maintenance and crew training for these SAS and Swissair Conquest 600 aircraft—owned by the Caravelle Co. Swissair (AW Oct. 5 p. 17) and which may possibly be designated the 990 by Caravelle—will be handled by the latter airline. The two Caravelles obtained from Swissair will be legally owned by SAS but, as in the case of the Conquest, can be re-allocated by the original owner after they have been in operation for four years.

Swissair and SAS will operate as a team within the interlocking agreement to pool spare and engine for the intercontinental DC-6B. Under provisions of the overall contract, each of the airlines will maintain spare parts and engine depots at designated terminals from which all the services can draw. However, Swissair, for example, supplies a Pan American World Airways DC-8 with an engine part from its spare depot at London, under terms of the co-operation agreement. This part must be returned from the aircraft immediately upon its return to New York and airfreighted back to London. On the other hand, if a Swissair-owned spare depot needs a part from an SAS DC-6B, it remains with the aircraft throughout its useful lifespan. The same applies to a SAS part supplied to Swissair.

The DC-6B cooperation is essentially an extension of the 30-year-old Benelux plan in which Swissair, Sabena Belgian World Airlines and KLM Royal

Dutch Airlines pooled spares for their fleets of Caravel 190s and 440s and Douglas DC-6Bs and DC-7Cs. DC-6Bs of both carriers are of the same model number and, as an economy move, spares for both airlines will be shared in a pool.

One or more additional European DC-8 operators may soon be brought into the Swissair-SAS pool, with KLM the best bet to become the third participant. Swissair also may push for a wide-ranging spare pool involving 16 to 17 companies and covering piston-engine aircraft as well as the DC-6B, Boeing 707, Caravelle and Conquest during negotiations at the 1961 annual general meeting of the International Air Transport Association in Copenhagen, Sept. 12-16. Here, however, parts will be stored only as a last resort since Swissair feels that the possible draw on a local carrier's inventory for a larger airline could be prohibitive.

DC-6B cooperation with SAS also extends beyond the spare pool, with Scandinavian Airlines System assuming responsibility for all but line maintenance on the three aircraft Swissair will have in service by September. Flight training is conducted at Atlanta Airport, a 45-min. drive from Stockholm, primarily because of its remoteness from inhabited areas, whereas the suburbs surrounding Zurich's Kloten Airport are more congested. The airline's flight training program, however, is under the direction of Swissair instructors.

For its initial service, Swissair is train-



FIRST Caravelle obtained from SAS begins service with Swissair May 21. Two Caravelles now fly to London and the Middle East.

ing a total of 44 pilots for the DC-6B, with the first group of eight now completing its transition course.

The pilots, most of them transitioning from Douglas DC-7Cs or DC-6Bs as first time through a five-week pre-flight course at Zurich, including 24 hr. in Swissair's Curtiss Wright-built DC-3 simulators, before reporting to Atlanta for training about one of the two aircraft which Swissair now has on hand.

Ongoing flight training efforts are laid down by the airline called for 12 hr. of flight training. In practice this figure has been trimmed to an average of only 8 hr. Swissair says that has been sufficient for the senior pilots chosen to fly the DC-6B.

Spending between four and 10 days in Atlanta, a pilot is taken through the complete flight syllabus including low-altitude maneuvering, two-engine-out flights and approximately 21 landings including 11 IFR approaches. The training plan is flown up to 12 hr. a day during which it makes approximately 18 landings.

After Atlanta, the pilot returns to Zurich for additional instrument training and another 12 hr. as the simulator. He then moves directly into the cockpit as either a copilot or captain flying the regular passenger run between Zurich and/or Geneva and New York, making the first three flights with a senior check pilot aboard.

As a parallel to the program, all Swissair instructor pilots were sent to Douglas' Long Beach, Calif., plant where they received a total of 14 hr. flying time before going to Atlanta to complete their training under two Douglas flight instructors.

Details of the Swissair-SAS co-

operation agreement were worked out after the airlines already had begun preparing for the DC-6B and each carrier had purchased a simulator on its own from Curtiss-Wright at a cost of approximately \$134 million each. Swissair, however, is sharing the SAS purchased Curtiss-Wright simulators located at Rossmore Airport near Stockholm and, in turn, is leasing a Caravelle simulator from Rediffon, Ltd., of London, for use by both carriers.

Making maximum use of its DC-8 simulators, Swissair often schedules a day for 5 or 6 hr. and then keeps the equipment in use until 11 p.m., pushing through its own pilot flight engine runs and, under lease, two-hour runs from two French airlines, Transports Aeriens Intercontinentaux (TAI) and Union Aérienne de Transport

(UAT). In its first five months of operation, the simulator had accumulated a total of 1,155 hr., including 412 hr. for TAI and UAT trainers. In an early air workload almost equally high.

With one DC-6B in actual service, Swissair is scheduling four round trips a week between Switzerland and New York, and plans to boost that number to 12 as Sept. 11 when all three aircraft are placed on the route. The lone Caravelle in service between May 21 and early this month when the second was introduced flew on a schedule of three round trips a day between Zurich and London, with three out every 10 to 12 days for overland and maintenance by SAS at Atlanta (WNA in Atlanta, the Caravelle flights were taken over by DC-6Bs).

During its first full month of opera-



PPE of Swissair's 11 Conquest 400s line the map at Zurich's Kloten Airport, the airline's home base. The Conquest made 5.5 flights a day on Swissair's short-haul European routes.



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tern—Mar 30 to June 30) or Delta DC-78s 11 round trips between New York and Switzerland, again with time out for overhaul at Athens, with a total of 2,560 passengers.

Configured for 92 economy, 26 first class seats, the aircraft had an outboard passenger load factor of 92.9% as opposed to 89.9% continental and the 93% which Aeromé Balmesville, Swiss executive vice president for planning and research, estimates as the DC-6 load factor on the North Atlantic run. It also carried 51,751 lbs. of freight and 11,017 lb. of mail for an overall load factor of 61.9%.

The Caravelle, with 10 economy and 26 first class seats, carried 74.9% passengers between Zurich and London on 70 round-trip flights during its first season of operation between May 31 and June 21. With its 98,718 lb. of freight and 11,360 lb. of mail, the Caravelle established an overall load factor of 61.9% for the season.

During its most popular flight of the day—the 11 a.m., 15-min. lunchtime run from London, the aircraft established a passenger load factor for the month of 98.4%.

Each day month a second Caravelle was placed in service, with the two aircraft alternating between flights in London and the Middle East on the following schedule:

- Caravelle leaves Zurich at 9 a.m. for London, arriving at 10:35 a.m.
- Aircraft departs London at 11:30 a.m., arriving Zurich at 1 p.m.
- Second Caravelle leaves Zurich at other 2:30 p.m. for Athens or at 2:55 p.m. for Athens.
- Second Caravelle takes off for London at 4:00 p.m., arriving at 6:15.
- Aircraft leaves London at 7:05 p.m., arriving at Zurich at 8:35.
- Second Caravelle leaves Zurich for London at 8:50 p.m., arriving at 11:35 p.m.
- Aircraft leaves London at 1:50 a.m., arriving at Zurich at 3 a.m., and goes into maintenance control in preparation for the 9 a.m. flight in London and, at the afternoon, switching over to the Middle Eastern run. The first plane, more white, returns to Zurich and goes into maintenance control before taking over the 4:00 p.m. flight to London.

All four Caravelles are scheduled to be in service next month with flights to London, the Middle East, Madrid and Scandinavia.

In its training program, a Swiss Caravelle pilot receives approximately 162 lb. of technical instruction on the ground, 14 lb. in the SAS flight simulator and an average of 55 lb. in the air, including approximately 11.17 lb. as pilot and 27 lb. as instructor.

Under present scheduling, Swissair will receive its first Concorde aircraft next March, approximately three

months before its proposed entry into service by the Federal Aviation Agency. Both Swissair and SAS will receive one aircraft in April and another in May, with Concorde flying on the Geneva order with deliveries in June and July.

Both Swissair and SAS will use the aircraft for the training of flight crew and maintenance personnel, Swissair FAA certification, putting three sets aside to use July to the Far and Middle East, South America and the S&S side, South Africa.

Concorde training and certification for both airlines will remain under the supervision of Swissair, although an instruction flight will be made from Athens because of the same problem at Zurich. To help maintain the aircraft, Swissair is establishing a string of 12 gates deep in the Middle and East East, each stocked with between 10 and 15 engines. A service network for the Caravelle is maintained by SAS, which serves the Swissair aircraft at all but one point, Tel Aviv, where parallel service is not offered by the Swissair network.

To ease the maintenance problem and provide more maintenance for its jet fleet, Swissair also is considering the possibility of contractually converting its Caravelles to the Mark VII configuration, substituting two 16,000-lb. thrust CFM56-24s for the present installation of two 11,700-lb.-thrust Rolls-Royce Trent engines.

Once the Concorde is in service with 12 first class and 94 economy seats, Swissair will pull back its Caravelles from the Middle East to replace its present European workhorse, the Caravelle 440, on some of the longer routes. Balmesville believes that 400 sq ft is about the shortest stage length over which the Caravelle can be profitably operated. Swissair never has been in place the aircraft on shorter runs, however, in order to keep pace with competition from other carriers. At Times, for instance, already is offering Caravelle service on the daylight line, from 308 mi. apart between Zurich and Paris.

In another move to meet competition, Swissair Boeing 767 service by Tel Aviv and Paris and Geneva and Zurich, each included in the jet market of the area, Swissair may place one of its DC-8 aircraft on its route to the Far East with Tokyo as the terminal point at the end of October when the summer schedule geared for tourist traffic routes, to be ended and the carrier's jet flights across the North Atlantic are resumed from 12 round trips a week to Europe.

The route is presently served by a Douglas DC-8B which Swissair trades its way to Tokyo from Zurich in approximately 44 hr., as opposed to the

35 hr. flight with stops planned for the Concorde.

Despite the report of jet purchase costs and the fact that during most of the year it had to use public transport in competition with jet transport on its major routes, Swissair in 1979 realized a net profit of approximately \$1.71 million as compared with \$1.181 million in 1978, and paid a dividend of 6% to its 10,568 stockholders.

Annual utilization for the year averaged 11.1 hr. per day for each of Swissair's 5 DC-78s, 9.1 hr. for each of its 7 DC-6Bs and approximately 7.5 hr. for each of its 11 Concorde 440s. Swissair hopes to reach a utilization rate of 10 hr. per day for its jet transports.

The Geneva utilization rate looks particularly good in view of the short stage lengths it operates. For instance, a typical one day schedule for a single day:

- Zurich to Zurich
- Zurich to Munich
- Munich to Zurich
- Zurich to Paris
- Paris to Geneva
- Geneva to Paris
- Paris to Zurich

To maintain such a schedule, Swissair has adopted the lightweight progressive maintenance system and runs its maintenance hangar in Zurich as a three-shift round-the-clock line, scheduling as much maintenance and overhaul work as possible for the late night and early morning hours when there is no customer traffic.

As a great effort, major overhaul periods are programmed for the months of winter and early spring when flight schedules are at their lowest.

Fuel Shortage Cuts Delta's Cuba Payloads

Athens—Delta Air Lines DC-78s, in 77 passenger configuration are carrying only 62 passengers on the carrier's New Orleans to Havana route because of a shortage of aviation gasoline in Cuba. Since Oct. 1, Delta's same supplier in Havana, has asked the airline that it cannot be responsible for what little fuel is available. As a result, Delta's flights to Havana have been cut, leaving fuel for the round trip and leaving the poultry in place.

In mid-September Delta plans to cut its daily service to Havana to three flights weekly as the fuel of declining load factors (AWM No. 25, p. 47). During December, January and February of 1978-79, the peak Cuban tourist season, Delta carried 1,345 passengers from New Orleans and Havana. Last year, the comparable figure was 704 including only one package vacation trip booked to Cuban government resort properties.

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THE FORTY FOUR. The Canadair Forty Four, with its combination of low direct operating costs, high block speeds and large payload capacity is the world's most economical cargo aircraft. Delivery schedules can be arranged to introduce the Forty Four into active service fourteen months from contract agreement.



Soviets Change An-24 Serial Number

Original print job on the Russian radio telegraph An-24 transport (AW June 15, p. 39) may have proved embarrassing to Soviet officials. Serial number on the craft was 8558 L1599 (USSR L1599), indicating that the craft's factory rollout may have taken place last year. Within two weeks after the L1599 An-24 appeared, the craft was displayed again with a lower serial job—the first with the serial 5558 L1560. Consequently, An-24s mentioned that the An-24 had begun test flight

Pressure Rising in Soviet Union For Better Airline Ground Service

Moscow—Pressure is rising in the Soviet Union for more vigorous efforts to eliminate the "sloppy" job, he terms the quality of flight and ground service in Aeroflot passenger operations. Construction of ground facilities is lagging and the attitude of airport personnel is indifferent to passengers, according to the Soviet press. Russian airlines are demanding that terminal accommodations be improved to the point where they match the quality of Aeroflot's first class transport.

The national newspaper Krasnodar is an extensive review of ground service shortcomings, notes that the USSR's Seven Year Plan provides for construction of a modernization of 90 airports in the 1959-1965 period.

But it said some steps made will be required to get this program rolling so that "the ground can be brought up to the level of the sky."

In the air, Krasnodar observed, the passenger first class is long. "Traveling now is a great joy. One can enjoy a comfortable and safe and enjoyable trip."

However, all this changes when a passenger gets off at a transfer point, or when his plane is unexpectedly delayed at an intermediate station. One ground or transfer is transformed into a night, failure service who seldom waits.

"There are no accommodations for him to spend the night. There's not even a place to wash up or to sit while he waits for his connecting flight or for the weather to improve or for his plane to continue."

"At the stand, but the cold and crowded passenger finds only little pity for him. A very popular and not durable building—wooden-floored—No

bodies can tell the traveler how long he must wait."

Chabakov, Krasnodar said, the ground price of air travel is expensive in spite of the fact it is important to greet him.

Aeroflot's Central Administration only makes its hands in a helpful program. It points out that a new, important place can be built in a matter of days, but for so many are considered as construction of a modern hotel or even a clubhouse. And in that time the six best guests moved forward, the hotel is once more too small and the dining room won't hold the baggage."

Quoted in Krasnodar on the lag in airport accommodations, the chief of Aeroflot's Capital Construction Administration said.

Building personnel obviously believe that construction deadlines are established just to be violated. We should, for example, have completed the airport at Vladivostok last year, but it's still not ready."

The situation is no better in Moscow. The Main Moscow Province Building Department is expected to start building construction at Krasnodar. Aeroflot has dragged on for over four years.

One of the Russian air travelers' most vexing problems, according to Krasnodar, is trying to get travel notes from beleaguered Aeroflot personnel. "The passenger has to figure out weeks of 10 pages of information he needs in a night."

To illustrate its point, Krasnodar cited the case of "Anatole" who sent a telegram from Moscow to his nephew, Alexei, in Rostov asking that he meet her place at the neighboring city of Tbilisi. Alexei needed Tbilisi airport built in

house before the scheduled plane arrival time and then said Krasnodar, the main airport began.

"The 11th CB, it still hasn't left Moscow, but got at the information center told Alexei with open color. Since the flight from Moscow required over six hours, Alexei returned home to Rostov."

"As a result, the house Anatole had no one to meet her at Tbilisi, where she arrived 40 days later. It seems that her plane was not in Moscow but at Krasnodar (only 180 mi. away)."

The Tbilisi information bureau didn't know that and didn't say to know about it, although it should have been responsible for determining the location of delayed planes. Probably," commented Krasnodar, "Tbilisi airport personnel were busy with more important things—such as discussing advanced methods of passenger service."

The Soviet newspaper emphasized that Tbilisi airport personnel didn't stand alone in the art of giving bad information. They have their rivals at Leningrad, Khabarovsk and other cities, large and small."

Krasnodar, Krasnodar observed, is no longer the morning passenger changing places for Muscovites that they wouldn't learn about their baggage—that it will be transferred to the right place for them.

But on arriving in Minsk they are told that not even a taxi has been found about their belongings. The Minsk airport chief sends each passenger with a "sacred" and "Krasnodar, again." Who lost the baggage and I'm held responsible."

Denying the situation with Krasnodar, Aeroflot Deputy Chief Budkovskii admitted that ground service shortcomings are a major headache.

"But what can we do? We still have made and inefficient personnel. We are trying to track them but obviously our effort is in this regard is having poor results."



**NOW
IN
SERVICE!**

The world's newest jetliner—the Boeing 720

... now flying on United Air Lines routes and soon to enter service with American Airlines, brings jet-speed and comfort to more cities. Later the 720 will go into service with Braniff, Irish, Lufthansa and Western air lines.

The superb 720 operates daily from shorter runways, yet cruises at more than 600 miles an hour. It's sleek, roomy and wonderfully comfortable... with the exceptional passenger appeal demonstrated by Boeing jets in service.

BOEING 720

Airline Income & Expenses—May, 1960

IN DOLLARS

DOMESTIC TRAFFIC	Passenger Revenue	U S Mail	Express	Freight	Charter	Fuel & Operating Expenses	Total Operating Expenses	Net Income Before Taxes
American	\$1,500,040	656,411	147,070	3,964,250		\$4,912,440	\$6,896,440	1,086,600
Boeing	2,591,802	184,990	46,620	191,470	15,180	4,918,916	4,934,624	157,178
Capital	4,163,642	262,242	111,250	121,142	10,770	4,778,226	4,808,221	265,416
Continental	4,470,308	70,000	43,000	62,500	3,000	5,908,400	6,000,000	861,908
Delta	1,508,800	176,000	114,000	344,000	81,000	3,495,800	3,526,800	982,000
Eastern	11,107,370	466,271	886,120	1,000,000	7,140	17,284,137	17,291,277	2,823,133
Midwest	4,202,310	60,438	31,300	129,400	11,000	4,744,600	4,800,700	8,610
Northeast	2,470,811	30,734	31,436	70,137		3,490,800	3,526,800	982,000
Northwest	1,770,430	31,270	100,100	1,000,000	10,000	3,526,800	3,526,800	982,000
Trans World	30,840,340	470,313	1,461,600	1,111,200	33,544,370	33,544,370	33,544,370	1,200,100
United	31,042,264	173,284	2,074,240	35,230	30,385,174	30,385,174	30,385,174	1,440,082
Western	4,347,374	120,714	76,300		49,174	4,818,180	4,848,300	80,194
INTERNATIONAL								
American	407,701	8,338	180	24,370		416,479	514,310	-106,609
Boeing	850,680	10,412		87,841		948,166	1,048,606	-20,122
Continental & Alaska	39,708	3,844			3,100	504,274	507,118	-20,410
Delta	374,000	4,836		8,000		391,000	374,000	70,000
Eastern	3,314,811	87,281	94,234	232	38,711	3,471,170	3,471,170	12,641
Midwest	134,108		732	3,304		180,444	181,000	-552
Northeast	71,410	104	577	2,804		11,484	10,400	10,400
Northwest	1,770,430	29,264	100,100	1,000,000	10,000	3,526,800	3,526,800	982,000
Pan American Constair	37,813,100	1,710,000	3,110,000	408,000	20,870,000	31,411,000	31,411,000	1,150,000
Alaska	440,000	17,000	18,000	1,800,000		380,000	441,000	27,000
Atlantic	10,111,000	300,000	1,247,000	414,000	16,668,000	16,668,000	16,668,000	2,000,000
Latin America	3,491,000	301,000	1,247,000	334,000	7,004,000	7,301,000	7,301,000	1,491,000
Pacific	7,701,000	790,000	940,000	18,000	6,800,000	7,301,000	7,301,000	2,200,000
Principles	1,671,000	34,000	190,000	190,000		2,400,000	2,400,000	200,000
Revol	445,000		49,413		410,587	410,587	410,587	10,413
Trans Caribbean	8,713,170	377,447	820,271	227,087	11,403,846	7,301,000	7,301,000	2,200,000
United	1,471,814	47,100	44,761		1,774,944	1,774,944	1,774,944	200,000
Western	381,424	5,207	14,531		400,161	576,344	576,344	10,000
SPECIAL SERVICE								
Air Express	844,310	5,344	10,710	20,400	2,019	1,004,881	8,841,340	-8,000
Boeing	341,441	7,404	1,010	3,710	6,840	370,910	401,045	-60,000
Capital	209,260	2,400	1,010	1,010	4,110	244,270	244,270	65,000
Continental	474,110	11,820	2,000	37,100	8,780	506,800	1,120,144	-65,000
Delta Constair	203,110	4,177	9,200		1,349	420,764	420,764	14,247
Midwest	791,447	1,414	2,400	11,110	14,224	100,444	1,000,000	71,000
Northwest	1,048,918	33,410	10,200	25,197	-344	1,008,210	1,001,700	146,310
Pacific	661,400	17,381	22,101	11,101	1,713	1,014,312	1,070,810	-56,402
Principles	105,344	10,040	4,500	10,100	17,844	1,000,817	1,000,817	-41,203
Revol	474,110	10,010	6,300	12,010	3,200	491,440	791,910	-34,110
Trans Caribbean	661,400	23,220	2,170	11,700	750,344	750,344	750,344	70,000
West Coast	514,440	9,440	2,400	2,400	2,200	536,840	700,110	-17,000
HAWAIIAN LINES								
Alaska	207,440	2,000		7,000	500	247,440	401,440	-54,000
Boeing	104,440	2,811		7,070	207,440	302,411	302,411	-45,000
CHARTER LINES								
AUTICO								
American Jet Airlines						499,816	1,410,210	710,394
Delta Type						194,440	884,816	690,376
Eastern						437,124	1,500,200	2,063,076
Continental & Alaska						431,202	1,000,817	200,340
Boeing						1,004,334	1,104,334	-1,000
HELEKOPPER LINES								
Chicago Helicopters	177,200	121,800				30,000	190,100	87,100
Los Angeles Helicopters	10,440	3,441	5,410	5,410		40,340	200,140	-22,700
New York Helicopters								
RAVENS LINES								
Alaska Airlines	200,700	40,341	2,140	40,426	140,307	470,800	601,007	-37,470
Delta Constair	176,434	10,810	10,100	10,100	4,074	180,426	193,400	-4,966
Boeing	12,134	5,810			40,307	194,440	210,140	-1,410
Delta	17,860	6,000	4,100	4,100	2,000	120,300	150,000	4,000
Northwest Constair	90,800	20,347	3,700	31,310	11,411	200,467	260,140	-32,470
Pacific Northwest	270,423	23,100			2,000	1,100,210	1,100,210	2,100
Boeing Atlantic	170,340	34,437			31,101	300,430	320,700	70,260
Norfolk Alaska	13,720	2,410			1,401	46,307	60,410	-201
West Alaska	90,704	10,112			12,100	174,444	200,444	110,000

* Non-scheduled passenger service.

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FROM THE EXPERIMENTAL BUMPER IN 1950 TO THE ATLAS IN 1960 . . .

CAPE CANAVERAL'S FIRST 10 YEARS OF MISSILE AND SPACE PROGRESS



Just ten years ago yesterday, the first experimental missile was fired from Cape Canaveral. Here, General Electric reports on this key U.S. missile and space research center's first ten years of progress.

A few men, a quickly constructed wooden "command post" and the firing of a hybrid Army War Corps/V-2 missile called **BUMPER 3** . . . this was the beginning ten years ago yesterday of what today is the largest missile test center in the world: Cape Canaveral.

AS BUMPER 3, developed under General Electric systems management, climbed away from the then Long Range Proving Ground Division, the only horizon-breaking landmark was a lighthouse tower near a cluster of houses. Today, this scene has been dramatically changed with miles of hard top roads leading to hundreds of launch sites, test centers, hangars, fuel supply areas and block houses.

Beyond this changed scene lies a record of more than 800 successful launchings that have been conducted by the three U.S. military services and other government agencies working with Air Force Missile Test Center personnel who maintain and operate "the Cape," or Station One of the Atlantic Missile Range and the island "downrange."

These launchings have paid immeasurable dividends. In the area of U.S. missile progress, Cape Canaveral test launchings have led to the present operational status of Thor, Atlas, Jupiter, Scout and Minutaur, and are now speeding the development of Polaris and Titan.

In the area of space technology, missile test flights from the Cape have proved the reliability of U.S. ICBM re-entry vehicles and the accuracy of U.S. ICBM radio command guidance, provided information on the field of radiation around the Earth and other valuable data about space environment and flight that will serve scientists in their efforts to conquer space.

In satellite programs, the successful launchings of Pioneer, Explorer, Transit, Tiros and other satellites from the Cape have paved the way for a whole new generation of orbiting bodies that will aid in communica-

tions, navigation, weather forecasting and in the protection of the Free World.

This progress has truly been the result of team effort. The military services and government space agencies together with companies like General Electric . . . a member of the Cape team since its Bumper 3 missile beginning . . . have made vitally important contributions. General Electric, its Defense Electronics Division and the Defense Systems, Heavy Military Electronics, Light Military Electronics, Missile and Space Vehicle, and Guidance Departments that are a part of this Division are proud to be a part of this team and contributors to this progress.

A unique 15 x 19-inch four color illustration, suitable for framing, of the historic first missile launching from Cape Canaveral is available upon request from General Electric Company, Section 160-83, Schenectady, N. Y.

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

HIST. CAPE LAUNCH



Was Corporal/V-2 missile solid Bumper 3 was fired by handful of Army and GE personnel on July 24, 1950. It provided vital data on both for early missile progress.

X-17 THREE STAGE MISSILE



First fired in July, 1958, Air Force X-17 re-entry test vehicle was designed to achieve high re-entry velocity and yield important information relative to ballistic flight problems.

EXPLORER I SATELLITE



This nation's first satellite was launched on January 31, 1958 from the Cape and is still in orbit. Army Jupiter-C booster placed this historic satellite into orbit around the earth.

FIRST PAYLOAD RECOVERY



First payload, a re-entry vehicle data capsule, to be recovered from space was launched by USAF Thor missile in 1958. G.E. built both re-entry vehicle and capsule.

FIRST ATLAS ICBM CONE



First Atlas re-entry vehicle to fly full ICBM range was developed by G.E. and launched on July 9, 1958 . . . general familiarity of Atlas for ICBM re-entry.

FIRST POLARIS SHIP LAUNCH



First Polaris shipboard launch was made from Navy's USS Observation Island on August 37, 1959. G.E. is providing Polaris fire control and overall guidance systems.

LONGEST MISSILE FLIGHT



USAF Atlas with G.E. radio command guidance and re-entry vehicle launched this May flew more than 9500 miles . . . longest free World missile flight recorded to date.

AMERICA IS ACHIEVING
IMPORTANT MILITARY
AND SCIENTIFIC PROGRESS
FROM CAPE CANAVERAL
MILESTONES
ONE THREE

AIRLINE OBSERVER

► Capital Shuttleholders Asia, employee-stockholder group voting to oust present management of Capital Airlines, has endorsed six of the 14 members of the company's current board of directors. Endorsement includes Board Chairman Thomas H. Nichols, Jr. and Gordon Y. Eklund, who also is head of the Debonair-Hollister Protective Committee. The endorsement also gave its support to members James R. Stockton, G. Rodell Moore and Raymond G. Luchok. It took no position on the reelection of Charles Macdonald or George Hume on grounds that their share holdings were sufficient to ensure their reelection.

► Midwest Airlines wants to take over the route between Kansas, N. Y., and Washington which Capital Airlines wants to drop (AW July 18, p. 45). Midwest has told the Civil Aeronautics Board it wants the route and would add Unalakleet and Hoon to it. The court also suggested that Algonquin Airlines serve Capital's present route from Washington to Buffalo via Whitehouse and Harrisburg, Pa.

► Air France now is offering 80-passenger flights. Under an agreement with Credit Lyonnais, French nationalized bank, the carrier plus covers not only the cost of the flight but also hotel costs, car rental fees and other incidental expenses. Initial deposit is 10%, with up to 12 months to pay the balance. Interest rate is 8.5%.

► Federal Aviation Agency has awarded contracts to the Hamilton Technology Development Center and Wilcox Electric Co. for the development of rotor-blade transporters that can be business and private aircraft. Final models will weigh about 14 lb. and will cost, under production, about \$1,000.

► Czechoslovak Airlines is using Russian-built Su-15 turboprop transports on its route between Prague and Baghdad via Athens and Damascus.

► Braniff Airways and Eastern Air Lines began interchanges service last week between New York and Bogota, Colombia, via Miami and Panama with Braniff's Boeing 707-120 turboprop equipment. Braniff will fly the aircraft on the Miami-Bogota segment of the route. Eastern on the Miami-New York leg.

► Edinburg Airlines has signed a letter of intent to buy two Boeing 720 turboprop transports for delivery in December, 1961.

► Delta Air Lines is now operating an all-jet schedule out of New York's International Airport. The airline is offering 10 scheduled daily using Douglas DC-8s and Convair 440 turboprop transports.

► Midwest Airlines will equip its five Convair 440s and seven Convair 240s with RCA AFD-50 weather radar. Installation begins this month, will be completed by January, 1962.

► Civil penalties totaling \$1,400 have been paid to the Federal Aviation Agency by seven passengers charged with violating regulations prohibiting drinking from private liquor supplies aboard scheduled transports (AW June 15, p. 49). FAA assessed a \$200 compliance penalty for each violator. Fines can be as high as \$1,000.

► Development Loan Fund will lend the government of Chile \$10.5 million for the construction of an international commercial jet airport at Santiago. Airport plans call for a 10,000 ft runway designed for single wheel loads of 62,500 lb.

► Aerob-ANA, Aerobian airline, has ordered two Fokker F-27 Freed tripart turboprop transports to bring its Friendship fleet up to a total of eight. Delivery is scheduled for early 1962.

► Original Boeing 707 turboprop prototype, the "dash eighty," which celebrated its sixth anniversary on July 15, is still being used extensively in the 707 series product improvement program. Plans now in undergoing a heavily instrumented program of investigating various high lift devices.

SHORTLINES

► Air Transport Assn. has revised its "Standard Method of Estimating Composite Direct Operating Costs of Transport Aircraft." Latest edition is the third revision of the report, which was first published in 1949.

► Air Line Pilots Assn. has filed a suit in Federal District Court in Chicago asking that Federal Aviation Agency be enjoined from depriving short pilots with FAA approval on turboprop flights. Suit was filed in a cross-complaint growing out of an injunction obtained by American, Pan American and TWA requesting pilots to accept flights on which the third pilot was displaced.

► Alitalia, the Italian airline, has introduced its third Douglas DC-8 turboprop transport on its transatlantic route, increasing jet flights to a daily service between New York and Rome. Carrier plans to have an all-jet service on the route by Aug. 1, with 11 flights weekly.

► Air France has been named general agent in North America for Transports Aeriens Intercontinentaux-TAI. Air France will handle all the privately-owned carrier's sales, traffic and promotional activities in the U.S., presenting TAI's Los Angeles-Tokyo route and the around-the-world route operated by one-stop services of the two companies.

► American Airlines and Continental Air Lines will begin Boeing 707 turboprop transport service between Los Angeles, El Paso and Houston Sept. 15. Under the interchange agreement, flight equipment will be supplied by Continental on the first six months of the service and by American during the second six months. American crews will fly the schedules between Los Angeles and El Paso, with Continental crews flying over the balance of the route.

► Independent Airlines Assn. will request CAB permission to enable its member airlines to provide non-scheduled, nonstop charter for \$12,978 in Lockheed Constellation equipment. Passenger's round-trip fare would average \$22.

► Pan American World Airways will begin Boeing 707-120 turboprop transport service from New York to Rio de Janeiro Aug. 1. Flight time on the 4,471-mile trip, which includes a 95 min. stop at Trinidad, will be 9 hr. 45 min.

► Progress has introduced a Douglas DC-7 all-cargo service from Miami to Georgetown, Lima, La Paz and Cochabamba on a weekly schedule. The service replaces a DC-6A all-cargo operation which makes this year.



FIRST with the newest in jet refuelers . . .



and first with the last word in jet fuels

Shell's new UNDERWING, rear engine jet refueler provides fast, accurate spotting - minimizes fueling time . . . considerably reduced danger of aircraft damage.

The driver no longer needs to "back in." He drives directly forward—avoiding any chance of damage to the aircraft. A transparent cab roof gives complete visibility for pinpointing the jet's refueling spot. All refueling equipment is up front. A right-hand sliding door enables the operator direct access to all fueling platform equipment. The entire procedure is fast, accurate and safe.

The new refueler holds 8000 gallons of AeroShell Turbine Fuel . . . the industry-wide claim for the fueling requirements of jet flying.

Shell—largest supplier of commercial jet fuel and aviation gasoline in the U.S.A.—guarantees the quality of these fuels by strictest handling techniques, proven and developed on Shell's AeroShell Turbine Fuel Equipment Laboratory.



SHELL OIL COMPANY

60 WEST 40th STREET, NEW YORK, N. Y.
100 18th AVENUE, SAN FRANCISCO 9, CALIF.



MEMO TO MICHAEL:

Your recent letter to the company has been brought to my attention. I am particularly interested in this paragraph,

I am in the fifth grade at Brown School and am very interested in aviation. When I grow up I want to be a aeronautical engineer if my mother will let me

Michael, I certainly hope you keep your desire to make a career in aviation. In my opinion it is one of the most challenging opportunities for the young men of America. The helicopter industry, and aviation in general, is helping to keep our country strong and we look forward to the help that boys like you can give when your time comes. The backbone of the aircraft industry is the engineer. We will always need good engineers with imagination and vision. You have that vision now. Please keep it. I'm sure that you can count on your mother's support when you are ready to take your place among the other young men who are playing a vital role in a vital industry.

Sincerely,

... THE
NATIONAL
DEFENSE
KAMAN
IS
PART
OF
THE
PLAN



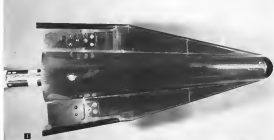
Strongarm Launched to Ionosphere For Electron Density Measurement

Radio transmitter in Strongarm period indicated 37 and 145 mc. rough-firm (right) and a master oscillator (second from left).



Strongarm rocket is being fired at Wallops Island, Va., in a series of ionosphere electron density measurements which began last fall. Also: Electronic Research Laboratories rocket (left) is composed of three John Deere stages. Nike Ajax booster (second from left) stage, modified Rocket (third stage) and solid-fuel stage (fourth stage). Yellow-covered drive unit (top right) carried 37 and 145 mc. transmitter in its oscillator base, with antenna elements acting as antennas. Control objects at top and center of view (left) are antenna testing supports. BRL developed SPORT system (below) to track and photograph the flight.





CONFIGURATION ABOVE resembles the one chosen for the Dyna-Sov vehicle and the only Bell Aircraft hypersonic glider proposals.

USAF Builds Capability for Hypersonic

By J. S. Betz, Jr.

Washington—Air Force has created a capability to manage the technical development of major hypersonic vehicles, previously by playing a major role in compiling the necessary engineering design data through study contracts and internal applied research programs.

Air Force's primary reason for developing across the board competency in this field is to allow a complete return to the traditional Air Force-contractor relationship without the technical difficulties which are acquired during the development of ballistic missiles.

The traditional relationship in which

technically competent Air Force personnel supervise the contractors' design and development work on new weapons has been abandoned in only one major instance—the crash program to develop large ballistic missiles. Ballistic Missile Division was set up in the Air Force's management agency for this program, and its technical advice came first from Ramo-Wooldridge, and then its successor, Space Technology Laboratories.

National Aeronautics and Space Administration and several research foundations and universities currently are making major contributions to the understanding of hypersonic aerodynamics and control mechanisms without direct Air Force support. But many such organi-



MODELS of hypersonic vehicles are tested at very high angles of attack.

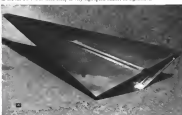
Development

zations also are assisting the USAF effort by developing design manuals for hypersonic aircraft under contract.

Wright Air Development Division is the Air Force group charged with technical management of the flying Dyna-Sov orbital aircraft which is now under development. This division is also the Air Force's management agency for advanced hypersonic systems which are still in the preliminary and conceptual design stages. To perform this advanced design function, WADD is sponsoring a wide variety of internal and contract applied research programs intended to give the organization an in-house capability to perform the complete preliminary design job for winged and manned hypersonic vehicles. This re-



DIFFICULTY of control reverts on hypersonic boost glider reflects one of the subjects of the Air Force Langley study of very high speed aircraft configurations.



POSITIVE DIHEDRAL on a hypersonic wing (model No. 4) gives vehicle a "see" bottom appearance. This increases the internal volume, reduces stresses in the wing and moves the location of maximum heating from the wing leading edges to the side along the center of the lower surface. Shovel nose (model No. 5) has been investigated for possible improvement in lifting ratio.



VARIETY OF CONFIGURATIONS studied for hypersonic flight is illustrated by the constant span shovel nose model of the left. It might be possible to reduce high temperature area at the expense of poor lateral stability with this shape. Many more wings (above) have been tested.



INCREASE in nose bluntness lowers the maximum temperature on a vehicle at the expense of aerodynamic efficiency.

TIROS GROUND STATIONS...



Nerve Centers For A Satellite

Over 25,000 informative cloud-cover pictures have been received from TIROS I since it was launched on April 1. In two months the satellite has completed 1000 orbits and transmitted 71,500,000 cloud-cover data. This means not only that TIROS itself has performed as planned, but that the complex problems of command and control, as well as signal reception and processing, have been successfully overcome. Like the satellite, the special ground station equipment was designed and built by RCA Astro-Electronics Division under the auspices of NASA and technical direction of the U.S. Army Signal Corps.

Major components of each of the four ground stations include:

- Five TV receivers and four beacon receivers used as diversity reception to maximize signal fading
- A programmer which pre-arranges different combinations of operating modes, and a 200 watt command transmitter
- A TV monitor to display the picture signal for the automatic recording camera. The camera is equipped to make either positive or negative film
- An indicator and one single computer which assigns an index number and size angle indication for each picture, used for photographic reference
- An attitude recorder which picks up the earth horizon signal for spin rate position computation

- Two standard telephone-type recorders to back up the monitor
- Two paper recorders to monitor forty teletransmitted satellite pictures
- An antenna programmer which directs the antenna to follow the orbit of the satellite when it is in range of the ground station

All program decisions are timed by a master clock which is supplied as standard time signals from WWV. In addition to normal picture direct transmission and record functions, the programmer can also command spin up, slow down and to the spin rate had decreased to 5.4 rpm's due to the effect of the satellite's magnetic field. On command from the ground, two solid pyroelectric spin-up rockets on the satellite were fired, increasing the spin to 11.5 rpm's.

AED's own ground design was used to process photos from the magnetic tapes for the first six hundred orbits. The integrated design and development of these TIROS ground stations is an indication of AED's capability in total satellite systems. This capability will become increasingly critical as more extremely complex satellite and probe systems are developed to advance man's understanding and control of his universe. To discover how you can draw on this broad R & D experience, contact the Marketing Manager, RCA Astro-Electronics Division, Princeton, N. J.



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house design capability is regarded as the key to good technical management.

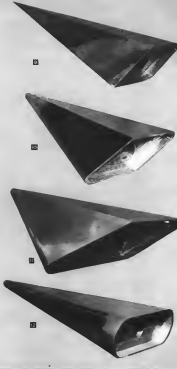
Aircraft and airborne missile programs are directed by WADD, which is supported by performance management functions and provides technical support. Management of these programs is handled by WADD's Directorate of System Management, and its Directorate of Systems Engineering, an informal advisory group. Development development is being managed by these offices, as is the B-70, GAM-87A Skybolt air-launched ballistic missile, the GAM-77 Green Quad deep-sea missile and all of the other Air Force weapons in development or airborne systems.

The third major WADD subdivision, the Directorate of Advanced Systems Technology, is the group which must be consulted to judge the state of advanced technology and has been directed to maintain a capacity for the complete preliminary design of winged hypersonic vehicles. An especially close interchange of information between the three directorates is maintained in the case of the Dyno-Saur program, which is just out of preliminary design and will provide more concrete information on hypersonic vehicles after it has made a few flights than all of the research performed to date.

Typical of the applied research programs supported by the Directorate of Advanced Systems Technology are these:

- Hypersonic configurations study by California Division of Lockheed Aircraft Corp. Objective of this study is a design manual containing analysis techniques for predicting the steady-state characteristics of hypersonic vehicles over a large speed range. Theoretical portion of this study is completed by about 50% of the total task in the Von Karman Gas Dynamics Facility at the Arnold Engineering Development Center over a Mach number range from 2 to 15.

- Study of flow characteristics around a lifting body during re-entry into the atmosphere is being conducted by General Applied Sciences Laboratories, Warhams, N. Y. Main problem in this study is concerned with the effect of the last boundary layer flow over a body as the external free-stream flow outside of the boundary layer. This effect is of special importance in determining the flow interference between two or more bodies on a hypersonic vehicle such as the wing, fuselage and stabilizing fins. Experimental portion of this study is being conducted in AEDC facilities in the Mach 5 to 25 range. Ultimate objective of this study and many others of a similar nature which are supported by WADD is a simple design manual which will allow aerodynamic heating and pressure distribution over a hypersonic vehicle to



WIND TUNNEL TEST DATA from the family of models shown can be used to determine the effect of leading edge bluntness on the aerodynamic and heating characteristics of hypersonic vehicles. Model No. 9, with very sharp leading edges, represents one extreme, while the large rounded wing leading edges on model No. 12 have about the maximum curvature which would be considered on a practical vehicle. Test data on this family of models will also contribute to the study of shock effects. Wings shown above are only a small portion of those tested at Tullahoma.



The Republic F-105D streaks to a new world speed record... powered by a Pratt & Whitney Aircraft J-75 jet engine

On December 11, 1959, the Republic F-105D fighter bomber roared over the Mojave Desert at 70,000 feet. The course was a 62.4-mile circle. With a wingspan of 41 degrees below zero, the Air Force F-105D slipped through the closed course flight to establish a new world's record of 1,116.44 mph.

Its highly advanced electronics, radar, and structural equipment enable the F-105D to achieve success at twice the speed of sound regardless of velocity, altitude, or target size conditions. Its speed and power make it one of the most versatile aircraft in history.

PRATT & WHITNEY AIRCRAFT

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be predicted rapidly, with the engineering estimates used today for supersonic aircraft.

• **Optimum flight paths** for winged vehicles which will minimize the aerodynamic heating problem are being investigated by the General Services Division. In this particular theoretical study, the effects of variations in heating rate to calculate the angle of attack, schedule to be followed by some types of winged vehicles re-entering along various different trajectories. These calculations are being made on an IBM 704 computer.

• **Study of the similarity** parameters pertinent to hypersonic flow is being made by Flight Sciences Laboratory of Buffalo, N. Y. Research another fluid number. Mostly number and the other fluid flow similarity parameters which have made it possible in the past for small scale model tests to be used in the design of large vehicles are not adequate for hypersonic speeds. The high temperatures of hypersonic flight cause physical and chemical changes in the air. An accurate mathematical description of hypersonic flow is much more involved than a description of supersonic flow.

• **Five degrees-of-freedom flight path analysis** for hypersonic vehicles is being conducted by McDonnell Aircraft Corp. making pertinent utilization of the results of an IBM 7090 digital computer. This program is set up so that a wide variety of problems may be solved quickly, from those involving point mass objects with two degrees of freedom to the most complicated six degrees-of-freedom studies of winged vehicles in which autopilot responses and rotating mechanisms effects are taken into consideration. Results of this work will be published in a WARD report which will describe quick, computerized methods for vehicle performance along any trajectory, with reasonable aerodynamic estimates and to make error and trajectory analysis about around flight paths.

• **Free flight model test program** is being managed by the Flight Branch at WARD. In this program, large scale models of winged hypersonic vehicles will be launched by Mach 20 by Air Force TS-609A rockets, which will be similar to the NASA Scout vehicles. The test of these models will be made within a year. They are now in the preliminary design phase. Two types of models will be used, aerodynamic models for external configuration studies and structural models which will carry full scale structural loads from hypersonic vehicles.

Flight Sciences Laboratory has the preliminary design contract for two aerodynamic models, and McDonnell has a similar contract for three structural models. In general, the models will test



HYPERSONIC GLIDERS which have highly heated, insulating skin to protect the hot-bearing internal structure from high temperatures will require a simple internal release for heat structural analyses. Models shown will aid in determining the best means of providing this release in a highly swept triangular wing. Model No. 15 has a modified cylindrical fuselage. Conical fuselages with less release and drag are used on Models No. 14 and 13. Model 16 has a built-up flat-plate fuselage, and the fuselage on Model No. 17 extends below the wing. Various degrees of leading edge bluntness also are studied.

Within two years Ford will land a space vehicle on the Moon



THIS LUNAR CAPSULE, now under development for NASA's Jet Propulsion Laboratory, is one of many space-oriented programs now under way at Aeronutronic Division of Ford Motor Company.

These programs—and many others related to advanced weapon systems and computer systems—are being carried out at Aeronutronic's multi-million dollar Engineering and Research Center, in Newport Beach, California. They emphasize Ford's rapidly growing role in meeting the needs of science and defense in the Space Age.

A booklet describing Aeronutronic's accomplishments and capabilities is available to you on request.

AERONUTRONIC

AERONUTRONIC DIVISION *Ford Motor Company*, SPACE PRODUCTS GROUP

Ford Tool, Detroit, Mich., Division

A 300-pound Lunar Capsule containing scientific instruments will soon make a "rough" landing on the Moon. It will be carried by a larger spacecraft to a location about 25 miles from the Moon's surface, then released. A retro-rocket will cushion its impact. The Lunar Capsule will transmit vital scientific data back to Earth for a month or more. This unique space vehicle will be the product

of Ford Motor Company's Aeronutronic Division.

experiments being used on the Boeing Dynaball and then will provide the first large-scale hypersonic flight data. If the model flights are successful and their instrumentation and telemetry systems function properly, they will produce the best data available for the design of hypersonic vehicles.

It is possible that this large-scale instrumentation will solve the problem of finding the correct velocity parameters for use in hypersonic flow. If this can be done at an early date, then the uncertainty surrounding most of the current large-scale hypersonic tests could be lifted. A large number of these tests have been made to date, but more questions still surround the interpretation of the data, and it is not clear exactly how it should be applied in the design of hypersonic vehicles.

Models which will be tested to subsonic speeds by the TS-405A rocket are called aerothermoelastic models by the Air Force, and it is probable that they will fail and disintegrate some where near the end of their flight trajectories.

Internal optical sensors program at WADC include aerodynamic heating measurements on highly swept wings at large angles of attack, ranging from minus 90 deg. to plus 90 deg. Studies are being initiated on samples which bodies for hypersonic vehicles.

Detailed studies are also sponsored on the low-speed flight characteristics of hypersonic vehicles, possible use of supersonic/hypersonic cooling systems at very high speeds, efficient air intakes for hypersonic speeds and other, other designs also pertinent to very high speed vehicles.

Solar Power Unit To Generate 100w.

Washington—Prototype satellite solar power unit designed to generate 100 w is being built by Hamilton Standard Division of United Aircraft for Wright Air Development Division and is expected to be ready for ground test this fall.

Following acceptance will invest approximately 900 aluminum reflectors 4 in. in dia. over a 100 sq. ft area. Reflectors, assembled in groups of 15 on aluminum tubing, will focus solar light on radiation collector in their center. The sun's heat is conducted to one end of a thermocouple whose temperature may rise to 1,000° while the thermocouple at opposite end, which is cooled by radiation from the reflector's back surface, may be reduced to 400°. Temperature differential causes a voltage flow.

Solar generator capability eventually will be increased to an output of 1,500 w.

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A landmark in engine instrumentation progress is the Bendix® Temperature-Vibration Monitor which simultaneously displays the readings of 40 sensors and a vibration sensor continuously located on all 4 engines of a turbine-powered aircraft. This data is presented on the flight deck of the aircraft in bar graphs form so that it can be continuously monitored and easily read.

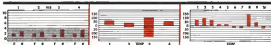
The average displacement of 8 vibration pickups is displayed continuously on the lower indicator bar with the top of the bar graph indicating vibration displacement on the grid scale. The maximum measuring of vibration simultaneously indicates excessive vibration on the jet engine.

The temperature analysis normally associated with exhaust gas thermocouples will locate faulty burners, bad combustion distribution and plugged nozzles or any unusual hot or cold

conditions around the turbine engine exhaust. The temperature display on the "all" position presents maximum and minimum temperatures on the upper methods may read continuously for the low response in reference to a temperature fluctuation at by the operator. The individual engine temperatures can be displayed on 70 bar graphs whose deflection can be read on the tube scale as differences above or below the temperature datum, and individual display may be accurately and easily read from the digital read-out dial.

The equipment, totally developed for BOND, is applicable to all active and military turbine powered aircraft. The equipment for the low engine installation is approximately 30 lbs and includes the Temperature-Vibration Monitor pictured above and a remotely mounted 1/2 ATR short box.

Continued



Vibration indicator for four engines has four and four graphs on each. Right of display indicates total vibration displacement.

Temperature "all" display indicating maximum and minimum temperatures above and below temperature datum for four engines.

Temperature for single engine indicates all temperatures including temperatures above or below temperature datum reference.

Scintilla Division
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Load Cell to Be Used in F-1 Rocket Testing

Type C-10 load cell built by Adhesive Load-Houston Corp. will be used to stabilize a horizontal load cell which will determine weight and thrust forces of the Rocketdyne F-1 rocket engine. Thrust down engines of National Bureau of Standards Washington, D. C., during the 100,000-lb capacity proving ring using as payload and to stabilize the Type C-10 cell. Cell, a compression unit weighs about 1,500 lb, is 75 in. dia.

PRODUCTION BRIEFING

Lochner Foundation for Medical Education and Research has a \$150,000 Atomic Energy Commission contract to explore the possibility of contributing to AEC biological research laboratory in Albuquerque, N. M.

Vita Laboratories Division of Vaco Corp. will continue to operate and maintain T-1000 Test Range instrumentation under negotiated \$1 million USAF contract.

Rocketdyne Division of North American Aviation has signed a negotiated technical and commercial agreement with Société d'Etude de la Propulsion par Reaction, Paris, France, for production and sale of small liquid propellant rocket engines. The 18-month agreement provides the French company provide

two rights for certain Rocketdyne-designed engines in conventional Equip-Turbo and two Rocketdyne holds under U. S. rights for \$12.7M engines.

U. S. Air Force has ordered 15 General U-28 four engine ability aircraft (left has contract of the General T10) which will be fitted with design and testing equipment for all weather operations. Deliveries will start in December.

Aviation-General Aviation-100A small jet rockets fired from National Aeronautics and Space Administration's Wallops Station are launching 180 lb payloads to altitudes of 150 mi for stellar and solar observations.

Westinghouse Electric Corp. is building an experimental nuclear powerplant being developed by Martin Co.

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Rocketdyne engines have powered most of the military and scientific projects conducted by the Air Force, Army, and NASA. New huge boosters of one and a half million pounds of thrust are emerging from the technical heritage of Atlas, Titan, Jupiter, and Redstone.

And even while today's countdowns go on, plans for tomorrow's ascent to space are being made. At Rocketdyne, engineers and scientists are investigating such advanced forms of propulsion as ion engines, nuclear engines, plasma jets, and xenon/hydrodynamic engines. Meanwhile other groups are at work on high energy liquid and solid propellants, and dramatic new devices for both liquid and solid propulsion systems.

Rocketdyne, a 12-year pioneer in rocket technology, was first with power for America's long-range ballistic missiles—first with power for Outer Space.



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ANALOG Vocoder, developed by Hughes Aircraft for use on the B-70 and B-58, permits 61 subunits in bandwidth to estimate encoding of voice communications with an increase in bandwidth (M4). General band vocoder (right) for point-to-point communications, provides duplex operation, weighs 200 lb. Vocoder decompresses speech into base channels which can be transmitted in digital form, then used by varieties of receiver to restore original speech.

Vocoder Increases Channels, Security

By Philip J. Klein

Washington-Self, lightweight airborne vocoder (voice encoder), which studies the nature of audio signals and converts them into a series of digital signals for voice communications and permits automatic decoding for military security, was described here during the recent Military Electronics Convention.

Vocoder techniques are likely to find use in manned deep space probes and laser exploration because the reduced bandwidth can transmit power requirements.

New vocoder was developed by Hughes Aircraft Co. under Wright Air Development Division sponsorship, for the North American B-70 and F-105, under a program known as Project Quadriplex. The project was to provide dependable, secure long-range air-ground communications. Strategic Air Command plans to evaluate the Hughes vocoder for possible use on existing bombers to increase security of voice communications.

Airborne Vocoder

The new Hughes airborne vocoder, which can encode voice in either analog or digital format, weighs only 60 lb., occupies 1.3 cu. ft., and consumes less than 100 watts. Hughes' A. J. Strommen explained here. (The report was co-authored by K. C. Stockhoff.) The unit is designed for simplex operation. A duplex model vocoder designed for

ground-based point-to-point use, weighs 180 lb. and includes circuits both for compressing and digitizing speech for transmission as well as converting digital information back into synthetic speech.

In vocoder experimentation tests conducted by Hughes, up to 95% of the individual words were intelligible, which should provide an overall intelligence intelligibility of about 95%. Strommen said. (Intelligence intelligibility is higher than that of individual words because of adjacent redundancy in sentence structure.)

Speech Compression

First vocoder was developed in the late thirties by Bell Telephone Laboratories as part of a program aimed at better understanding of speech and more efficient methods of transmission. In recent years, the military services have sponsored considerable research in the field of speech compression, aimed at reducing the bandwidth required for voice communications in order to squeeze more channels into the radio spectrum and/or to improve security (AIEE Aug. 17, 1955, p. 126).

Naturally, a bandwidth of about 3,000 cps is required for voice communications of good intelligibility. If encryption is required, voice must be converted into digital format which increases required bandwidth to about 12,000 cps, according to Strommen.

The Hughes vocoder studies the

bandwidth required for voice communications in between 150 and 500 cps, permitting up to nine times as many voice channels as conventional (uncompressed) voice communications. Encrypted vocoder voice can be transmitted with a bandwidth of only 3,000 cps, the more bandwidth needed for conventional unencrypted communications.

Basics of Speech

The human voice, Strommen said, consists of two basic types of sounds:

- **Vowels sounds**, or vowels, produced by vibrations of the larynx under pressure of air from the lungs.
- **Unvoiced sounds**, or consonants, produced by movement or position of the lips, tongue and nasal passages.

The voiced sounds, or vowels, are the predominant carrier of information in human speech, while the unvoiced sounds give speech the characteristics which make it possible to distinguish one person's voice from another's. The voiced sounds consist primarily of harmonics of the frequency at which the larynx vibrates, usually in the range of 50 to 3,00 cps for men and as high as 750 cps for women. The unvoiced sounds have no definite harmonic frequency pattern, being composed of frequencies randomly distributed throughout the spectrum and varying in amplitude according to the sound being produced. Strommen said. In most instances, voiced and unvoiced

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Another product of

speech is not even simultaneously in human speech.

These are several different approaches to the design of a vocoder. The approach used in Hughes is called "fixed channel analysis." In essence, a series of 12 bandpass filters, vowel formants, are decomposed, or separated, into sound energy in 12 segments of the audio spectrum from 200 to 4,200 cps, after first having passed through a voice-gate, gain adjustment, detector (VOCAD) in which speech volume is automatically adjusted to a constant level.

The bandwidth of the individual 61 cps vocos from 160 cps at the low end of the spectrum to 755 cps at the high end.

The output from each bandpass filter passes to a corresponding speech analyzer which measures the power density of the sound in its assigned frequency range. The output from each spectrum analyzer is then fed to an electronic modulator, or tone modulator, which transmits the magnitude of each analyzer output in time sequence, once every 11 milliseconds.

The output of the multiplex can then be transmitted as pulse amplitude modulated signal (PAM), or converted into binary form, as desired.

Receiving End

At the receiving end, the process is essentially reversed to synthesize sound that resembles human speech. These are the same number of spectrum channels and bandpass filters, each carrying the same sequence of the spectrum in the transmitter vocoder. An audio energy source, referred to as the "base generator," provides the energy for vowel or vowel sounds, while another called the "vowel generator" supplies signals that produce the unvoiced, or consonant sounds.

The amplitude of signal received from the transmitter vocoder for each segment of the audio spectrum enters the appropriate synthesizer to produce a sound of comparable power intensity. The output from all 12 synthesizers, after passing through filters which are most accurately known, are then combined, amplified and fed to a loudspeaker.

At any instant when the speech is predominantly unvoiced (consonants), a vowel in the transmitter vocoder, called the "pitch extractor" is activated.

This transmits a signal to the receiving vocoder which causes it to automatically discover its "base generator" and substitute a "tone generator" which supplies the random frequencies contained in the unvoiced sounds.

At each instant as the human speech contains both vowels and consonants

simultaneously, the combination is treated as if only vowels were present and the base generator is not activated.

The output of the transmitter vocoder can take the form of pulse amplitude modulation in which the output of each of the 12 spectrum analyzers is defined by one of eight levels, while the pitch extractor signal is quantized into 64 amplitude levels.

Modulation Techniques

Normal voice can be digitized directly using pulse code modulation or delta modulation, but such techniques require 23,000 to 28,000 bits per second for adequate quality. Speeches and this high bit rate is seldom economically justifiable for only one voice conversation.

With the vocoder, its output can be converted directly into a digital bit stream which requires only about 7,000 bits per second data rate. Furthermore, digital error rates as great as 1-2% have negligible effect upon speech intelligibility, whereas they would come up to 10% of the chances in an ordinary telegraph system to be in error, according to Strommen.

Various types of pulse modulation or frequency modulation can be used to transmit the digital bit stream. The use of vocoder and digital transmission techniques should improve the reliability of voice communications in the high frequency band in the face of both natural and man-made interference, Strommen indicated.

Strommen said that any desired level of secure transmission of speech signal can be achieved through use of digital bit stream transmission of voice.

System Savings

For point-to-point communications, a number of vocoder bit stream transmission can be time multiplexed with a significant saving in spectrum, both two and out, according to Strommen. Using the existing state-of-the-art, it is possible to transmit 12 fully occupied speech channels, with a substantially higher average to peak power ratio, using facilities that now provide only 25 unoccupied speech channels, and with much less complex multiplexing equipment, Strommen said.

Using a bit stream rate of 2,800 per second, the present vocoder design has achieved voice transmission rates of 85 to 90%, giving near-perfect simulation in intelligibility, according to Strommen.

The present Hughes airborne vocoder is fully transmitter, except for one intermediate device used as a rate converter. Airborne rate rates 250 words per second and 915 words, which can be used to operate up to 390C transponders. Ground-based duplex vocoder can 350 words per second and 1,312 words per second.



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HOT ENGLISH tube is placed in output beam of semiconductor to measure photo cell sensitivity. Work being done by Dr. W. E. Spott (above), RCA Laboratories, Princeton, on electron emission from semiconductor junction is supported by Army Signal Corps.

Semiconductor Emission Studies Aim at Better Electron Tubes

By Barry Miller

FR. Monmouth, N. J.—More efficient electron tubes are the goal of a series of research studies into electron emission from semiconductor being conducted here at the U. S. Army Signal Research and Development Laboratory and in a few other laboratories throughout the country.

Semiconductor may prove to be an efficient electron source for tubes once scientists gain a better understanding of electron emission from single crystal and polycrystalline semiconductor and the mechanisms responsible for it. This could replace the conventional heated cathode-long a major barrier. The heated cathode in the electron source which radiates tube operation possible. It also has its wasteful side. Heating requires power which adds needless weight and the heat generated must also be removed.

Heater Filaments

For this reason and the desire to do away with the heater filaments, results a first source of tube failure, scientists for some time pondered over and sought ways of improving electron tubes by using unheated or "cold" cathodes, which would not radiate like polycrystalline semiconductor.

Although the major portion of a con-

vent series of government-supported studies of electron emission at the three types of the Signal Laboratory in nearby West Belton and elsewhere are not now seeking new devices but rather a fundamental understanding of emission phenomena, some practical semiconductor electron tubes are under development.

Cold Cathode

Eighteen months ago this laboratory, along with its contractor, Tung Sol Electric Co. of Newark, devised the results of several years' effort—the cold cathode tube (AEC Feb. 2 1959, p. 64). The cathode of this device is coated with a porous polycrystalline silicon semiconductor compound, made which emits electrons in sufficient quantity so that the tube can be operated without the customary tube warmup time and without the need for a filament and its supply. The tube thus avoids a frequent source of failure: requires less power than comparable thermionic devices and saves the space which normally would be occupied by the filament hardware.

Possible to this work, an second wave of study, sponsored by Jack A. Barco and others at Bell Telephone Laboratories, into electron emission from the surface of hot-barrier semiconductor junctions. Such research has been observed at several laboratories in a series



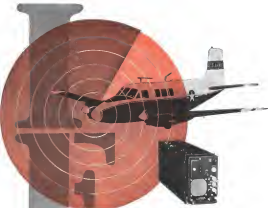
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bor of semiconductor-cathode generation, silicon cathode and diamond among others. These observations led to speculation about the feasibility and potential advantages of a hybrid electron tube, with the semiconductor junctions replacing the several cathode, which might be beyond this early, exploratory research.

Research Efforts

The Signal Corps, and to a lesser degree, the Navy Bureau of Ships are now supporting a number of complementary research efforts regarding in the first steps in this direction. The Army's effort, according to Dr. Dietrich Ederhals, and Louis N. Hirsch at Evans is proceeding along two lines. These are:

- Further study of cold-cathode tubes and the phenomena, still not thoroughly understood, behind electron emission from polycrystalline materials
- Study of electron emission from single crystal pn junctions

At present, the relation between the two emission phenomena is not known. Both are of some type of internal field emission, Hirsch says. In the pn junction, an internal electric field imparts sufficient energy to electrons for them to escape over the surface barrier. Emission from impurities also involves a form of internal field emission and possibly, Hirsch says, the same mechanism responsible for emission from pn junctions also occurs in producing emission in the cold cathode. In the case of electron emission from single crystal pn junctions, the Signal Corps is backing fundamental studies of what it calls "half" electron emission under a two-cent, \$168,000 contract with RCA Laboratories in Princeton, N. J.

Half electron emission refers to the heating of electrons alone and not the crystal lattice itself as is done in normal thermionic emission.

Density increased

As part of this work, the company has reproduced and simulated earlier work with pn junction electron emission. RCA scientists increased the density of electron emission and the total current emitted from the junction by deriving new techniques for coating the junction with oxides. The oxides coating lowers the work function which acts as a barrier, preventing electrons from escaping from the semiconductor.

Uncoated silicon junctions emit fractional microampere currents, earlier oxides coating boosted this to several orders of magnitude. Now cathode current are obtained on a pulse basis before the crystal surface heats up and electron emission drops. These pulse experiments indicate, Hirsch says, that a high order of magnitude increase



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from electric and gravitational junctions is possible.

RCA is trying to harness not a complete theory to explain junction emission. One interesting byproduct of its work, according to Dubschek, was a recent observation of field-assisted photo emission. Light focused on a back-biased silicon or germanium pin junction produced electron emission even above that expected from electron emission. Besides offering another tool for studying electron emission, this suggests the possibility of obtaining longer wavelength infrared photo detectors.

In addition to the work at RCA, Nuclear Corp. of America, Des Plaines, N.J., recently began a search for a suitable group of semiconductor junction emission under a \$150,000 Navy Research of Marine contract. Nuclear is looking at large band gap semiconductor which have the theoretical advantage of reducing the effect of electron affinity—which might make the reverse treatment unnecessary—and a more stable device to testing.

Magnesium Oxide Types

Since the initial demonstration of cold cathode tubes, development has continued on the magnesium oxide type of tube and emission. One of coloring various oxide cathodes in electron guns for cathode ray tubes has been demonstrated, according to Dubschek. The cold cathode has been used in combination with secondary emission, the photoemitter. One morning and beforehand problem is cold cathode emission. However, it is the field in electron emission due to having after short operating periods. This could be overcome, Dubschek says, by proper physical design so that the cathode could be cooled to room temperature after emission tests.

Rather respectable electron densities, in the neighborhood of 100 ma/cm², roughly comparable to fluorescent emission, are being achieved in the laboratory here.

The cold cathode also tends to be non-uniformly in order of magnitude more so than a better quality thermionic cathode. This rules out its use as pre-amplifier stages although the tube is not so extreme that the tube cannot find duty as an output amplifier. Non-uniform oxide preparation does lower the uniformity. But it is not possible to know whether these effects are a fundamental barrier. For the time being, the Signal Corps is anxious to learn what mechanism or mechanisms cause emission in an effort to know how they can be controlled.

Currently, test-lance Signal Corps work which may lead to some of these projects comprises:

- \$100,000 one-year contract with TungSol which involves the study of



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Boeing Studies Antenna Radiation

Scale model of a Boeing B-52G jet bomber is used in measurement of radiation patterns given off by the aircraft's antennas (AW Apr 11, p. 101). Work is under way at Wichita, Kan., division, model can be rotated around two axes as signals are transmitted.

ness properties, impedance and other characteristics of solid cathode tubes as a function of different proportions of impurities inside and other compounds.

A \$75,000 two-year contract, awarded in mid-June to Palco, for the task of putting together a theoretical explanation of the mechanism involved in solid-cathode emission. Palco will conduct very little experimental work, but is expected to design the experiments to determine the nature of the emission mechanism.

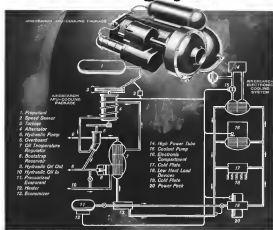
Total electron emission from magnesium oxide is well ahead of that from pyrochlore. Emission densities from pyrochlore appear to be on the rise of through it is hard to isolate the emitting surface and therefore its area of the density. Total emission, however, is still not as close as the magnesium oxide type of emitter.

Besides this work on what might be called internal field emission, the Signal Corps, the Navy and

the Air Force are supporting work on external field emission conducted at Langley Research Institute. According to Hirsch, internal and external field emission may be related fundamentally. Emission densities obtained at Langley with high external fields are appreciable, about 10⁷ amp/cm² although total emission currents are not yet in the nanogram region. Langley will study multiple-pulse emission under a two-year \$215,000 Advanced Research Projects Agency contract awarded in mid-June by the Signal Corps. It will attempt to determine the feasibility of multiple-pulse field emission cathodes (high-power cathodes). Bellhop's support of Langley work, to the extent of \$71,000 annually, as well as Air Force support, are to be placed into the Signal Corps work budget.

A number of other companies, including Westinghouse, are known to be studying electron emission from solids with a variety aim of eventually producing better electron tubes.

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operating in the missile or space vehicle. The cooling system in the example shown here uses liquid ammonia as the expendable refrigerant and such heat load as a separate temperature control valve. Alternator and compressor, turbine assembly and APU liquid propellant fuel tank are packaged after approximately 3000 psi compression. World leader in the design and manufacture of cooling and accessory power systems, AirResearch has

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Capacitors	1.1
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CASE HISTORIES



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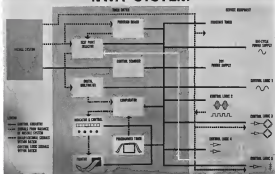
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MISSILE ENGINEERING NWA SYSTEM



DATAC equipment under test used in multi-carving submarines and their AS-16 launchers will be installed at the Naval Weapons Area, Charleston, S. C. The equipment is nearly identical except for address of power supplies and a response time.

New Polaris Checkout Devices Developed

By Russell Harkins

Anchorage, Calif.—Datonic automatic checkout equipment for Navy's Polaris fast ballistic missile, worth of about \$15 million of business for Northrup Division of Northrup Corp., grew out of a basic test designed for its particular application and was developed with \$75,000 of company money.

Lacking all of the specialized test components which must be associated with a specific application, Datonic (digital automatic test intelligence check out) was intended by Northrup to be tailored to a variety of systems by the addition of proper signal sources, measuring devices and displays. The equipment needed to adapt the basic Datonic to a system to be tested is much less than that needed to develop a completely new set specially for the system to be tested, according to Northrup officials.

This advantage paid off in February 1970 when Navy Special Projects Office decided it needed a new Polaris check-

out system quickly. After studying Datonic for two weeks to determine whether it was suitable for the job, Navy let a contract to Northrup to develop a test start built to commercial standards five months later on Aug. 1. Since then Northrup has received orders for additional versions to be installed on all George Washington-class submarines, their AS-16 Polaris-class launchers and at the Naval Weapons Area, Charleston, S. C.

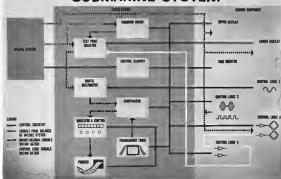
Tight Schedule

Dr. William F. Bellman, Northrup general manager, attributes the success of the company in winning the Polaris-Datonic contract largely to the ability to install tight Polaris program schedules because of the building block development technique. Bellman cites the rapid release of technology in the field of checkout equipment has helped meet responses to incorporate such new discovery in their equipment while maintaining any possibility of early delivery. Because of this, missile sub-

assemblies in the field ahead of their checkout equipment. Often, he reports, the performance margin sought cannot be and by the system for which the equipment is designed. In the second generation of Polaris-carving submarines, Datonic assemblies will be incorporated as part of an improved system called TRACE. Northrup is conducting development work for TRACE under contract to Lockheed Missile and Space Division, system integration and software contractor for Polaris.

The design philosophy behind Polaris-Datonic is to assure the readiness of the missile with a minimum amount of testing. This approach requires reliability of both the missile and the checkout equipment by supplying redundancy and cutting down operating time on components. Datonic installation aboard submarines is limited to determine whether or not the missile can be launched safely and reach the target. Therefore, the emphasis is on the functional testing of complete subsystems

SUBMARINE SYSTEM



BOX DIAGRAM for submarine-installed Polaris-Datonic shows the testable programmatic controller is shaded area labeled "Basic Datonic". Northrup adds a variety of service equipment to adapt the basic programmatic controller to a particular missile, capsule or electronic system.

rather than on detailed trouble shooting.

The value of knowing exactly which component has failed would be limited on the submarine environment since the opportunities for repair work are limited. Only one small crew has access to the base of the missile in its launchers.

The two major subsystems which can be replaced at sea in a standard practice, the guidance capsule, including the slide platform and the guidance computer. A complete supply of spare capsules will be carried aboard to replace installed ones which malfunction. These will be kept in a controlled environment, continuously monitored by the two, and maintained in storage just like those in the tubes to ensure a quick change if needed.

Northrup officials point out that in sea there is usually more unexpected maintenance than in a shore environment. Some years ago this was allowed in the Polaris checkout and maintenance plan, though it would be contrary to standard procedures. If there is time and need to replace or repair parts other than the guidance capsule it is possible to reach and check some components with test support and other standard troubleshooting sets. Occasionally, if a subsystem other than the guidance capsule is found to be seriously out of

MEETRONICS Datonic VII RT mock test and maintain equipment is tested at Anaheim, Calif. plant before purchase by Navy. Special acceptance tests standardize missile elements.



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influence the results most common in the tube. The standards of reliability designed into the inside are set high enough to make the probability of its unreliability low.

While Datas is not intended to provide a detailed check of individual components, a skilled inspector can quickly identify a fault from the replaceable module level to within the amplitude of an out of tolerance reading. The way the reading varies with time etc.

Bellows says it would be possible to give Datas the capability of checking the components of a system in complete detail if the module exhibited more trouble and if a great accuracy in the checkout equipment could be accepted. However, such a piece of equipment cannot be justified in the Polaris system system. Bellows blamed the city of Polaris Datas to that of a man checking the operation of a nuclear set by switching the picture and looking to the usual. Without an equipment or staff he can decide whether the set is operating badly enough to call in a man. But to find a weak, low component counts trouble with the complex tools and a much higher degree of training.

Related Systems

Norcross officials predict a widening market for the Datas and related checkout systems named Datascan and Datascope. Datascan is a small checkout system using a large percentage of sub-circuit counts and designed for easy integration with digital computers. Datascope will include some parts elements and will come closer to the state of a manual checkout set. Some experiments have been in the advanced system program on being laid into the model Datascan for Polaris.

Some of the features of most all tested Norcross checkout system which are being fed into the Datascan improvement program include: the authorized circuits replacement of mechanical switch tape reader by a photoelectric one and replacement of computer motion in the control system by switching diodes. One of the advantages sought in these changes is reduction in the man load to make on-site detection more difficult.

Datascan subjects Norcross thinking on the subject of manual checkout equipment. A manual checkout would have been too large and complex if the new Datascan was required because of the necessity of duplicating main components for the full inventory of warlike, explosive and electronic systems. However, all system checkout sets would have certain features in common. They must be able to turn

Propellant Briefs from Gallery Chemical Company

New fuel for Air Force by late summer—Gallery is now modifying the Government-owned plant at Huntsville, Ohio, to produce pentaborane under a new 39-million Air Force contract. Plant was originally built to produce high-energy boron fuels.

Pentaborane production begins late this summer for Air Force requirements only. At the same time, at least, no pentaborane will be available for commercial sales. Also worth noting: plant modification still maintains our capability for high-energy fuel production.

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Ordnance	At 1000/14 psi	At 1000/2 psi
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F-1	360	460
G-1	327	421
NP-1	328	413
H ₂ O ₂	316	399
CKO-P	306	391
NaCl	306	390
NO ₂ /ClO ₂ *	302	388

*More than NO₂/ClO₂, Norcross Pentaborane, a new solid oxidizer, will appear in the column next month.

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Write for Bulletin—Pentaborane C-1800

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COMPLETE
ENGINEERING
DATA

PROBLEMATICAL RECREATIONS 24

A gambler devised a game to be played with a friend. He bet it the money in his pocket on the son of a gun, heads he won, tails he lost. The coin was tossed and the money landed tails.

The offer was repeated and the game continued. Each time the bet was for \$5, the money then in his possession. Eventually the number of times he lost was equal to the number of times he won. Quickly now! Did he gain, lose, or break even? —*Public Economics Weekly*



It is about time that we told you about our research group in San Carlos, California. This group is a rather powerful capability for the advancement of knowledge in electron physics. And in our adjacent San Carlos manufacturing facility they can find out in a hurry whether theory can be translated into hardware.

ATTENTION TO LAST WEEK'S PROBLEM: If the conclusion were not valid, then every toss would have a different number of heads, and you'd run out of heads before you ran out of tails. It's valid.

LITTON INDUSTRIES
Beverly Hills, California

equipment on and off, feed control signals to the system, measure its response against selected criteria, and report the results of the comparison to its operator. The Debo sets run to build a set having three features and three custom-engineered elements which must be peculiar to the system being tested.

A successful problem in the design of checkout equipment is that of determining whether a malfunction indication is produced by a failure in the system being tested or by the checker set itself. To some extent, self-checking features can be designed into the set, but Northeon engineers regard this as a luxury that, because of its additional complexity and a serious amount of additional unavailability. In Datas-Polara, it is used only in the digital mechanism and in test signal sources. To evaluate the functioning of the engine Debo, Navy engineers will be able to run rapid self-diagnostic routines with modules switched out of the checkout loop.

Modified for Submarines

Northeon drew on the experience of Naval Electronics Laboratory, San Diego, for help in modifying Datas for use aboard submarines. NEL has collected much information on the stresses placed upon electronics at sea. Following NEL's recommendations, Northeon has replaced electronic components and modules to withstand the shock loads. The marine enclosure of the Datas equipment rack is designed for 9g shock loads and 10-Hz cpm vibration. Its three tiers of modules are wired together through quick disconnects. Although the rack can be jostled through severe battles, singly to be installed in the boat. Coolant air for the electronic equipment is passed through the double walls of the equipment.

The mounting of the enclosure is made flexible to let it compensate for the straining of the ship's structure under sea loads. When advanced compression of the hull by sea pressure can cause the soft deck in the missile control center to move up or down as much as two inches. The enclosure is suspended from double hinges on the bulkhead above it to allow the enclosure to swing and tip without being cracked or ripped apart by the stresses of the ship. Flexible mounting also gives protection against damage to components by the shock of detaching deck charges.

Each Polara-carrying submarine will have two Debo sets installed in the missile control center. Either one can check all the modules, or they can be divided for speed. The equipment also allows the operator to switch sets to determine whether a malfunction

TWO NEW VOLTAGE-CONTROLLED SUBCARRIER OSCILLATORS For High-Level or Millivolt Signals

When millions of dollars ride on a single missile flight, precision instruments are necessary to assure accurate, reliable data. In FM intercepting systems, subcarrier oscillators are well known as precision instruments. They are not equalled in linearity, intelligence frequency response and fidelity, efficient signal-to-noise power gain, and stability of all characteristics under aircraft or simple flight conditions.

Two new voltage-controlled subcarrier oscillators now available from **emr** are the Models 184C and 185S. The 184C millivolt oscillator operates full bandwidth with +10mV into a tuning, balanced, tunable input. Common mode rejection is typically 120dB at 10C and over 70dB at 10 Hz carrier frequency.

The Model 185C is a rugged, precision subcarrier oscillator, packaged in a hermetically sealed 1/4" cube. It converts high level signals of +5, +10, +15, or +20 mV into an FM subcarrier signal with a conversion linearity of 0.1%. For rugged, accurate, stable subcarrier oscillators for any application contact **emr**.

For complete information contact:



Electro-Mechanical Research, Inc.

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Model 184C
VOLTAGE-CONTROLLED
SUBCARRIER
OSCILLATOR

CONDENSED SPECIFICATIONS

184C

Input: +5 to +20 mV into 50 ohm
Output: Any ground return up to 50 ohm into
100 to 1000 Hz or 1000 to 10000 Hz
Linearity: 0.1%, or better straight line for
+10 mV
Bandwidth: 100 Hz to +10% dB to 20 kHz
3 second settling
Input impedance: 100 ohm minimum, variable
Max 1000 cycles
1000 elements: 1-10 mV and 100

185S

Input: 100 mV minimum into 50 ohm
Output: Any ground return up to 50 ohm into
100 Hz to 10000 Hz
Linearity: 0.1%, or best straight line for
+10 mV
Bandwidth: 100 Hz to +10% dB to 10 kHz
3 second settling
Input impedance: 100 ohm minimum, variable
Max 1000 cycles
1000 elements: 1-10 mV and 100



Model 185C
VOLTAGE-CONTROLLED
SUBCARRIER
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engine power BY CATERPILLAR

NEW COMPACT DIESEL ENGINES AND ELECTRIC SETS

Announcing a new line of Caterpillar four-cycle Diesels that sharply reduce physical dimensions and weight-to-horsepower ratio. Features of durability, fuel economy and dependability, long associated with Cat four-cycle Diesels, are retained.

- Four-cycle Premium Performance ... at No Preload in Price
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For complete performance specifications on these new Caterpillar Diesels or on the complete line, see your Caterpillar Dealer. Or, write to Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U.S.A. Ask for the catalog on the complete Caterpillar Engine line.

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D320
130 HP
60 KW



D330
180 HP
75 KW



D333
270 HP
125 KW

equal or being caused by the results of the checkout set.

The basic Dataset consists of a performance timer, with an integral precheckout reader, control sensors, program board module, test point reference, display, computer, indicator and control, tape magazine and printer. It commands service equipment specially selected to Polaris to generate predicted test signals and other service equipment measures the output of missile subsystems for comparison by the basic set.

Three Levels of Use

Dataset-Polaris has three levels of use—watch mode, test mode and operate mode.

- **Watch mode** is a continuous monitoring of aspects of the missile system which could indicate hazard to the host as well as the monitoring of the readiness of critical missile and weapon elements.
- **Test mode** is the periodic event-driven check to make sure the launch and flight control systems are ready to function properly.
- **Operate mode** is the final ready-down check, made under pressure of time.

The watch mode begins when the first missile comes aboard and remains in effect continuously with a broken call, qualified man shows on dash of the display panel. Dataset is connected to the various subsystems of each missile through the fire control switchboard. Watch mode measurements are displayed on a separate panel. Part of the panel is used to input or output hazardous errors in each missile including:

- Safe ready switch position
- Watchdog timing failure
- Ignition and fuel stage separation (leakage)

Eleven environmental factors are monitored in the other half of the watch mode display panel:

- Coolant temperature
- Coolant coolant flow
- External pressure of solid propellant motor
- Tube humidity
- Tube coolant flow
- Space gas turbine engine temperature
- Space gas turbine engine coolant flow
- Header (compressor second standard tube) temperature high
- Header temperature low
- Air sampler to detect hazardous nuclear radiation products
- Launch tube temperature

Some of the environmental factors are not associated directly with the missile. In these cases a NoGo (go down on the circuit) responsible for these factors will sound an alarm and turn on a malfunction indicator without placing a missile on a NoGo status. After launch of a missile, on return

CLOSER THAN YOU THINK



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ENGINEERING REPORT ON BENDIX COMPONENTS



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If you have a navigation instrumentation problem, benefit by our proven skills in this specialized area. Call or write today.

Eclipse-Pioneer Division

Teterboro, N. J.



out-of signal is automatically sent from the control to maintain the display at that scale.

Procedure for the control of test mode operation will require the operator to use a special typed program to perform all advanced operations. This type cannot be changed in the field.

When a reading on the test mode is out of tolerance, the test program is locked at that point. A measurement repeat button can be pressed to double check the out-of-tolerance reading. If the reading is marginally out of tolerance, the fix control supervisor can order the operator to push an override button. This can be used to continue the test in search for checks related to the out-of-tolerance readings. If the measurement repeat control causes a later reading to indicate "Go," the typed program of the test program will continue automatically unless the Defect is placed under manual control to prevent it.

While operating in the test mode, Defect performs these three unique loop tests:

1. Light control loop gain check, a read with the stable platform, parallel signal at zero, the guidance computer off, rate gyro oscillation readings generated Defect bypasses all other subroutines in the subroutines and the control under test and supplies a signal simulating that of the computer guidance capsule. The loop gain is obtained by measuring the feedback voltage from the guidance potentiometer, amplifying them and comparing them with limits as tabulated programmed on the tape. As an out of tolerance condition is then signaled and the actual value of the consequence is printed on a read out tape for a permanent record.

2. Guidance computer flight control loop is performed with the stable platform guidance signal at zero and rate gyro switched. This control subroutines three subroutines of the flight control stepped motor, which are in order to a stop in an ordered position. Data are shown (pitch or roll) at each stage in sequence in the test. Potentiometer feedback, provides the test signal for comparison with tape values.

3. Stable platform-flight control loop is tested with the guidance computer out of action, the flight control system stepped motor is ordered to zero. Stable platform-flight control loop gain is checked by using the stable platform pitch, roll and yaw, guidance approach and a predetermined signal. When the guidance signal is a known angle, the rate deflection is measured to see if the control response is within tolerance.

Also checked are heading precision, fixed loss, and fixed temperature.



Kiwi-A prime motor equipment (vertical barrel-shaped device, about 3 ft. high and 3 1/2 in. diameter), with a radioactive core of plutonium-239. Hydrogen gas, heated to thousands of degrees, was discharged into the stream through a cone.

AEC Fires Kiwi-A Prime Reactor System Under High Heat State

Judson Platz, Nav-A, power ran of Kiwi-A prime, a reactor motor system in the latter program to demonstrate the feasibility of nuclear reactor propulsion, has been conducted at first test site. In the experiment, hydrogen gas flowed through the reactor system for several minutes under conditions of constant heat.

The Nav-A nuclear reactor system is being operated jointly by the Atomic Energy Commission and the Naval Associates and Space Administration (NAV Jan 6, p. 102).

Scientists of the Los Alamos Scientific Laboratory, which is conducting research and development in the nuclear

reactor development phase of the program, disclosed after the reactor ran that instrument readings indicated that the test was conducted at scheduled, but that final reports would have to await examination of the reactor.

Following the experiment, the reactor was taken on the reactor-controlled safety car on which it is mounted, to a remote maintenance building for disassembly and examination.

Several hours later, at various levels of nuclear heat within the reactor, are scheduled for later this program with Kiwi-A 3, the reactor system similar to Kiwi-A prime.

ENGINEERING REPORT ON OTHER BENDIX COMPONENTS

GEAR HEADS

Compact units that provide output motor speed reduction.



These easily detachable heads are available in output frame sizes, and supply reductions in ratios ranging from 1:1 to 40:1 (90 L). Head bearings are Class A, N, D, or better, and gears are cut to AGMA Precision II tolerances, or better, with lead-in, held to 20 minutes, or better. Adaptable to variety of motor and motor generators. Write for details.

1/2-INCH LOW INERTIA MOTOR

Designed for instant response in servo systems.



The CE-100-48-A1 Bendix low inertia motor is a two-phase, 400 cycle induction type and is one of the smallest motors available for 200 mv systems. Measures only 6 1/2" in diameter and 1 1/2" in length. Head consists of a lightweight rotor that rotates on permanent ball bearings, a two-phase stator, and a stationary shaft housing. The stator motor has tapered shaft, has units that are threaded with other type shafts and with center tapped ends of windings.

Manufacturers of
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Teterboro, N. J.

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MEASURED CHARACTERISTICS 1. Total Drift: less than 2"/hour (uncompensated), less than 4"/hour per G. 2. Storage Temperature: -65°F to +200°F (higher temperature models available). 3. Extremely stable thermally, with warm-up time to 5% of damping from -66°F within 7 minutes. 4. Characteristic Time Constant for 5 degree memory angle unit = 0.87 milliseconds. 5. P.M. Torquer with better than 0.05% linearity and 1 rad/sec peak steady-state torque. Unpack it, put it in the system - it's ready to go. Availability - 90 days. Write or TWX for detailed test data on the QI-HS (Norwood 835-U, or field offices listed below).



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TWX: Norwood 835-U TWX: Alameda 989-5

anted by the moving interference of the two lines which are attached to translucent scotch tape.

The TTE display has two rates, one called terminal rate scale which represents a map diameter of 70 nautical miles and one called display rate scale which represents a 700 nautical mile diameter map. The pictorial display measures 15 x 15 x 2 in.

•Sperry Gyroscope Co., Great Neck, N. Y., also will supply a pictorial display driver for the NAVC program. This will be based on the company's display input ATN 118 display local opto for the Accu. This display device also will represent geographical position with a spot of light. The display surface will measure 11 x 15 in.

Other systems being planned to control pictorial displays for civil aircraft include Aero Division of American Bosch Arms, Brando and Collins. The devices, most of which come from military designs, are being built to such varying degrees of sophistication.

ATC Applications

Among the air traffic control applications for coating of aircraft equipped with pictorial display systems are:

- Parallel departure tracks for local operations would eliminate ground delay by permitting parallel flight paths.
- Straighten approaches to all corners would be possible with the pictorial displays. Pilots could follow approach plate paths which would permit the straight-in approach.
- Lower minimum altitudes would be possible in that better scans could be obtained.
- Downing climb and descent paths for arrival of varying speeds would be of particular benefit to jet aircraft.

Flight Evaluation

The flight evaluation of the ACE Electronics pictorial display instrument took place in the company's Area Coach simulator 123. Upon checkout from Teterboro Airport, N. J., the aircraft's Tacan was turned on and the display indicator connected. ACE's engineering test instrument was equipping from Tacan inputs rather than from VOR. DMEIT due to the paucity of operating VOR stations when the program began.

The 6 x 6 in. map can be held in the pilot's lap or, in this particular example, could be mounted on an emergency egress handle between the pilot and copilot seats. Just where to put the display poses something of a problem as it must be close to the pilot, yet not get in the way of looking at the sky. On jet transport aircraft, holding the pictorial display could become a third pilot function.

The likelihood map was mounted by the 15 x 10 in. map scale and the map was initially positioned such as one has

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SPLIT-SECOND INFORMATION

An effective Army must have split-second, exact combat intelligence. Republic's Missile Systems Division is working on one means of fulfilling this need for the U. S. Army with the AN/USD-4 Swallow system, a completely designed ground airborne intelligence-gathering system.

The SD-4 system includes an all-weather, jet-powered surveillance drone, mobile ground command and information system, and associated ground support equipment. The drone will be field-launched and employs any of a number of surveillance sensors. This high performance unit will permit the field army commander to extend his view beyond the horizon to gain up-to-the-minute information. Its mission completed, the SD-4 will return, be recovered and readied for a new mission.

The airborne ground SD-4 Swallow system was designed and is being developed by Republic's Missile Systems Division under contract to the U. S. Army Signal Corps.

REPUBLIC AVIATION

MISSILE SYSTEMS DIVISION

INDIANAPOLIS, INDIANA 46219



PacAera Turboprop Engine Test Facility

New turboprop engine test facility at Pacific Aircraft Corp., Burbank, Calif., features a Chrysler dynamometer which will handle both U. S. and British engines of up to 4,000 shp. Above, an overhauled Pratt & Whitney RB17 engine has been tested through engine operating cycle. Company says the dynamometer accuracy is better than one half of 1% of the observed reading. Instrumentation is located in a separate room.

tion near Newark, N. J. The weather was VFR, with about 8 mi. in haze, however, flight was made at 5,500 ft. and higher altitudes due to high density traffic.

Initially, we landed on the liftoff track on an all-weather landing of 120 deg., the attitude fairly flat, following our course. Close up to the station, the ground display will suggest the same distance even due to height in all distance measuring equipment. Upon reaching the liftoff track, the vehicle indicated this by drifting in a tight circle about the Tacan station in the center of the display.

Proceeding in course, however, the pop armistice staff and began tracking as indicated.

The ACZ RT-1 display demonstrated to American West did not have the "off" warning flag which will be accompanied on production models. The equipment did indicate loss of azimuth signals by drifting in a circle about the center of the display. Loss of distance signals caused the vehicle to search along the rail length of the radial track.

The display permitted three distinct checks of groundspeed while flying off course. This was accomplished by flying a landing and towing the pop over a known distance on the map. Wind drift data is readily downloadable from when flying off radial corner.

It seemed to this pilot, that to best utilize personal display information, one

should fly his directional gyro and use his display as a constant check of his position. The pilot who is new to the device may become frustrated by the little bug only to find his heading has drifted considerably long before an off course movement of the attitude can be detected.

In-Flight Test

During our March ATB, I selected the 7.5 mi. scale on the Tacan, switched to the appropriate ring and turned to a direct heading to La Guardia Airport. A manually related index on the display is used to determine off-course corners. The index wheel, similar to an abacus playing board is used to line up the attitude with the destination. Course is read from compass rose on the rear panel of the wheel.

The heading to La Guardia from Midfield was 305 deg. Maintaining this heading with occasional corrections in the log defined all course to the right, the 11 n.m. was home. The vehicle moved on course to a position above La Guardia Runway 35 (which marked as the 7.5 mi. on scale map), where upon a visual check verified our position directly over the marker.

This is not to imply that the personal display equipment can be used to direct a precision approach to a runway, nor is any company prepared to market the device for this purpose. Indeed this data system must preclude the use of

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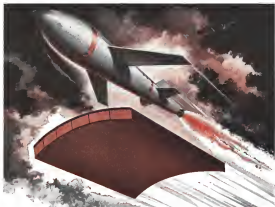
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Mixed experience shows that in certain heat transfer situations no one material will perform as well as two (or more)—one insulative with pressure high-temperature facing.

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1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K insulations, and 4) inner facing.



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plus the outstanding advantages of Min-K insulation—as insulative as core that has the lowest thermal conductivity available for service temperatures up to 2800°F steady-state and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of air.

Wide range of facings

For the hot face, the install designer can

specify Min-Klad Interlok in a wide variety of heat-resistant and/or abating materials—silicones (AKF-40), and stainless steel and other heat-resistant metal foils and meshes. For some requirements, the core face can be made of a different material...for example one that offers characteristics required for bonding or finishing to other surfaces and parts.

Like all J-M Aerospace insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component linings of any shape or size. Write today for technical specifications. Address: Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE **JM**
A Division of

the display for low visibility approaches. Additionally, ACF says that its display based on video inputs will be accurate to 1/32 in. That means a possible error of 1 in. (1,280 ft) in low ranges, hardly precise enough for a low approach. The pictorial display will prove of value in a positional check during VOR and radar approach and during several approach procedures.

Holding Pattern Rise

One important advantage of the pictorial display will be the ease with which a pilot can adjust to a holding pattern. To check this, a simulated holding pattern was drawn on the surface of the display and flown with little difficulty. Following this, a similar circuit was drawn on the display, surface and followed. At first, it is difficult to step precisely on the circuit line, but the advantage of the equipment is that the pilot instantly recognizes when he is off course and the necessary correction is obvious.

The ACF Electronics display system designated RT-1, is a rectangular 6 in. square and requires only electrical connection to VOR DME or Telen equipment. To operate the unit a map printed on transparent material is mounted beneath the active plane surface. The map is coded to automatically shift the equipment to the correct mode upon insertion. Scales at least as small as 1000 ft/mile will be 10, 20, and 45 m/m.

Beneath the map a slotted plastic disk rotates so that the rotating unit is beneath the VOR station in the center of the map. Servomechanisms at the unit rotate the disk in response to aircraft inputs and move the article (as a risk and pointer) along the radial slot to represent the distance report from the DME transponder.

In this manner the area instrument tracks the aircraft position about the map.

The display presents no pen from interfering the pilot where he has been, nor does it present heading information. This can be approximated, of course, by entering the leg's track.

ACF Models

ACF Electronics will produce its pictorial display in several models. The RT-1 will incorporate, with scale, a scale of 80 ft/mile per mil. The unit also will handle individual map scales. The RT-1B, described above, will handle only map scales representing some of the bulk and the slow center to draw the map rolls. Both models employ Arco AF 1-6-000. The larger RT-1 model measures 64 x 64 x 14 in. and weighs 41 lb. The 34 lb. RT-1B measures 64 x 64 x 2 in.

Equipment needed to operate the ACF pictorial display in a VOR receiver,



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Eyes of SAC, by Raytheon

Raytheon radar capability flies with the Convair B-58 Hustler, helping point the way at speed Mach 2-plus and altitude X.

Accurate, long-range eyes, this search radar-and-radome by Raytheon, as subcontractor to Sperry Gyroscope Co., is the most sophisticated in the world today, and marks Raytheon as the first electronics company to integrate radar and radome development for a high-performance aircraft. Other Raytheon airborne radars include B-58's Doppler

Radar and Boeing B-52's Search Radar.

To date, over 1000 Raytheon radars have been delivered to our Strategic Air Command.

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**EQUIPMENT
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Convair B-58 to Be Flying Testbed for J93 Turbojet

Specialty designed pod which will carry a General Electric J93 turbojet engine (powerplant for the North American B-70 Valkyrie) is installed on the belly of a Convair B-58 Hustler prior to flight (AW July 16, p. 70). Engine will be lightened in this configuration to investigate air starts, transient control and afterburning; it also will be used to test ground handling characteristics. In flight, with the J93 operating, the B-58's four F7Hs would be throttled back from normal cruise power settings.

a DMEIT transponder and a Radio Vaguet Indicator. The power requirement is that required to operate the DMEIT, 26 v a c, 400 cps.

ACF says that following what is called the position accuracy of the display is 10 in.

Equipment Modification

The small full-size "off" warning flag and red light accommodations for night use are provided. ACF says that the equipment can be modified to provide for XY displays operating from doppler navigator inputs.

This is true of most of the general display devices.

The maps used in the ACF general display are produced for ACF by Jeppesen & Co., Denver, Colo. Just what information to include on the maps has proved a problem to ACF. The maps will not require standard navigational charts, so Jeppesen thus would not include all the information. For America is testing the ACF display and their pilot's comments will determine this information.

Navy Contracts For Terrier-Tartar Devices

Automatic checkout equipment for Convair Terrier-Tartar launch of missiles is being produced at Boeing Mfg. Co., Portland, Ore., under \$6 million Navy contract. Equipment will develop under direction of Navy Bureau of Weapons and Johns Hopkins University's Applied Physics Laboratory, is designed to perform complete missile

checkout in their weapons, according to Boeing President Trevor Cashner. Green and red lights indicate functioning or faulty missile, respectively, and test equipment also radiates specific detection status.

Interchange of plastic modules permits the same basic test set to check out

in different modules in the Terrier-Tartar group.

Production under the Navy contract will be started in the company's Pasadena facilities, then transferred to a new \$4-acre facility in Moorpark, Calif. Boeing's backlog now is about \$9 million, highest in company's 10-year history.



Boeing Produces Small-Turbine Castings

American castings deliver are for reduction with output housing for Boeing Industrial Food and Drexler's 400-hp small gas turbine engine. Casting is left has been removed from molten metal, giving sphere is still studied. Coming at night is being treated. Internal configuration of the casting requires some care in the molten process.



Test control and data needed to operate and maintain the space age.



These technical brochures describe systems developed for the space age by Consolidated Systems Corporation. All are operating systems... on the job today... producing data in space age applications where time and performance are critical. Send about them. Circle the brochures that interest you, let your name and address on the margin of this page and mail to CSC.

New Consolidated's mass spectrometers designed to analyze elements in space space — ground data logging system for aerospace research. Write for full information.

CONSOLIDATED SYSTEMS CORPORATION
1800 So. Diamond Ave., Monrovia, California



CORPORATION
a subsidiary of
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FINANCIAL

General Dynamics Leads Military Contractors; Boeing Is Second

Washington — General Dynamics Corp. scored defense prime contracts amounting to nearly \$1.5 billion in 1959 to move into top position among military contractors.

In a summary of major 1959 awards, Defense Department reported General Dynamics replaced Boeing-Amples Co. as its top contractor. In the second spot Boeing received awards totaling \$1.18 billion. That was the only firm to receive more than \$1 billion for military work.

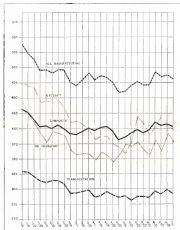
Defense last year awarded \$21.7 billion in prime contracts. The 100 top companies and their subsidiaries received \$15.9 billion, or 73.7% of the total.

Advances from the 1959 defense contract list were made by Lockheed Aircraft Corp. and North American Aviation Inc., both up one place, to third and fourth respectively, Grumman Aircraft Engineering Corp. from 47th to 12th, Aero Corp. from 51st to 20th and Rockwell Chemical Corp. from 79th to 27th.

General Electric Co. dropped from third place to fifth. Chrysler Corp. from 12th to 28th, Republic Aviation from 11th to 26th, Northrop Corp. from 25th to 4th, and Curtiss-Wright from 24th to 19th.

These are the top 100 firms and their subsidiaries listed on rank with dollar value of prime contracts and per cent of defense total.

RANK	COMPANY	1959 DOLLAR VALUE OF PRIME CONTRACTS	PER CENT OF DEFENSE TOTAL
1	General Dynamics Corp.	1,491.0	6.9
2	Boeing Aircraft Co.	1,180.0	5.4
3	Lockheed Aircraft Corp.	1,100.0	5.1
4	North American Aviation Inc.	1,000.0	4.6
5	Chrysler Corp.	900.0	4.1
6	Grumman Aircraft Engineering Corp.	800.0	3.7
7	Republic Aviation Corp.	700.0	3.2
8	Northrop Corp.	600.0	2.8
9	Curtiss-Wright Corp.	500.0	2.3
10	Aero Corp.	400.0	1.9
11	Rockwell Chemical Corp.	300.0	1.4
12	General Electric Co.	200.0	0.9
13	Boeing-Amples Co.	100.0	0.5
14	Boeing-Amples Co.	100.0	0.5
15	Boeing-Amples Co.	100.0	0.5
16	Boeing-Amples Co.	100.0	0.5
17	Boeing-Amples Co.	100.0	0.5
18	Boeing-Amples Co.	100.0	0.5
19	Boeing-Amples Co.	100.0	0.5
20	Boeing-Amples Co.	100.0	0.5



Aviation Stock Prices Show Some Recovery

Both aircraft manufacturing and airline stock prices showed signs of recovery in the second quarter of 1960 after a decline that accelerated in the first quarter. The sharp decline of aircraft stocks after the U.S. went down in Korea can be dated beginning with the week of May 1. Recovered in other stocks occurred after the Civil Aeronautics Board announced its vote of urban aviation. The chart is based on Securities and Exchange Commission computations and on SFC's index in which the base year 1959 equals 100.

NOW!



MODEL G

NOW Piper presents the Apache G command.

Best in class of the world's most popular executive line, with great new color comfort fast new including new picture windows, beautiful new styling and door, new improved color air system.

Other new improvements, too. New, easier access wheel steering and lighter in-flight rubber loads, new, improved, more finely adjustable

high-beat carburetor system, higher generator capacity (50 amp), higher permissible gear-down (130 mph) and gear-up (131 mph) speeds.

And it's better in the Apache G is the most important feature you need in any airplane: dependability.

Dependability of components...dependability of system...dependability of power plants...dependability built the result of design refinement and improvement in design by millions and millions of hours of operation, world-wide dependability that's been proved out in well over 100,000 Atlantic and trans-Pacific ferry flights.

The Apache G gives you the most economical two-engine transportation, too, with lowest direct operating expense plus lower insurance cost, lower depreciation because it's proved for lower than any other line...still only \$28,999.

BEST SEAT IN THE HOUSE! That's the verdict of all who have flown in the Apache G. Fly next with new two window seat on each side. Greatly improves pilot's comfort of flight, too. And one of many new features in the latest Apache G.



For full details on the new Apache G, see your Piper dealer or write Piper Aircraft Company, Dept. G-7V.

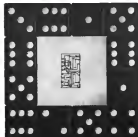
PIPER

PIPER CORPORATION
Wichita, Kansas, Pennsylvania

ATTRACTIVE LEASE AND FINANCE PLANS

RAVE COMPANIES	2011/1985	2011/1985	2011/1985	2011/1985	2011/1985
13 International Services	100.0	100.0	100.0	100.0	100.0
14 International Services	100.0	100.0	100.0	100.0	100.0
15 International Services	100.0	100.0	100.0	100.0	100.0
16 International Services	100.0	100.0	100.0	100.0	100.0
17 International Services	100.0	100.0	100.0	100.0	100.0
18 International Services	100.0	100.0	100.0	100.0	100.0
19 International Services	100.0	100.0	100.0	100.0	100.0
20 International Services	100.0	100.0	100.0	100.0	100.0
21 International Services	100.0	100.0	100.0	100.0	100.0
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27 International Services	100.0	100.0	100.0	100.0	100.0
28 International Services	100.0	100.0	100.0	100.0	100.0
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86 International Services	100.0	100.0	100.0	100.0	100.0
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91 International Services	100.0	100.0	100.0	100.0	100.0
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93 International Services	100.0	100.0	100.0	100.0	100.0
94 International Services	100.0	100.0	100.0	100.0	100.0
95 International Services	100.0	100.0	100.0	100.0	100.0
96 International Services	100.0	100.0	100.0	100.0	100.0
97 International Services	100.0	100.0	100.0	100.0	100.0
98 International Services	100.0	100.0	100.0	100.0	100.0
99 International Services	100.0	100.0	100.0	100.0	100.0
100 International Services	100.0	100.0	100.0	100.0	100.0

FROM LABORATORY CURIOSITY
TO MISSILE TRAJECTORY...



MICROELECTRONIC GRAY MATTER FOR

TOMORROW'S air and sea launched ballistic missiles will fulfill a pivotal role in the nation's military arsenal. Directing their flight will be revolutionary guidance computers, miniaturized to a point far beyond the limit of conventional design techniques.

But before this degree of miniaturization can be achieved in a computer that must be more than a laboratory curiosity a radically new design philosophy must be applied.

Engineers at G.E.'s Light Military Electronics Department are meeting the challenges of size and sophistication by pursuing a predominantly functional approach to micro-electronics...exploring the versatility of tunnel diodes and other semiconductor in conjunction with thin film circuit values.

And by designing for microminiaturization from the start, not only is it feasible to achieve far greater component densities—the development of standardized circuits and functional modules also reduces the numbers of components and connection interferences, significantly enhancing predicted reliability.



MISSILE GUIDANCE

Electronics engineers with experience and interest in this burgeoning field are invited to write informally for additional technical data or information on specific professional opportunities.

Address inquiries to Mr. R. Bach,
Department 64-WD.

LMED

LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC



FRENCH ROAD, UTHA, NEW YORK



"FRATERNAL TWINS"

The unit at left represents a missile-borne computer developed by Light Military and awarded by conventional techniques to meet the limit of 1960's state of the art. The 1961 experimental model along side (providing equivalent function) will be designed for microelectronics employing LMED's thin film values in modular construction. It is about 1/10th the size of the "Fraternal Twin."



1960



1961

HONEYCOMB

as an
energy absorber



- for limiting personnel protection devices
- for protecting air-dropped supplies
- for impact limiting safety linkages
- for missile instrument recovery assemblies
- and other applications to limit destructive G-loads to pre-determined levels

While honeycomb materials are used principally in light weight, high-strength sandwich structures, increasing emphasis has been placed on the use of honeycombs to absorb forces external to shock-loading systems. Such control is highly desirable in cushioning the impact of air-dropped supplies, protecting instrumented missile assemblies, providing impact limiting linkages in landing gear systems, protecting against shrapnel stress, and protecting top deck occupants in high speed vehicles.

The Problem

Insulation reactions against impact absorption are primarily typified by low level test descriptions such as the structure or materials, and small maximum allowable stopping distances. Such descriptions as mechanical springs, spacer or solid rubber, foam, cork, and wadding generally exhibit superior characteristics in that the force transmitted through these shockers in the shock limit stopped increases continuously through the duration in which the shocker is contacted. In addition, many of these materials do not absorb energy, but merely react to it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance would be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be substantially reduced.

Advantages of Honeycomb

Honeycomb core materials tend to follow with a constant linear curve, as shown in Figure 1.



The initial peak on the curve represents the point at which compression failure begins. This peak can be lowered by pre-tensioning the core to produce slight initial compression failure. When subjected to further or subsequent loading, the post-tensioning force prevents immediately to carry the loading load, as shown by the dashed line curve in Figure 1.

The main characteristic shows the appearance of aluminum honeycomb core before and after compression failure.

By designing a honeycomb core assembly with a specified cell depth this con-

stant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycombs, and most similar honeycomb core materials fabricated from other materials and fibers. Figure 2 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further improved by filling the cells with various insulating materials. Detailed information is available to assist the designer in the specific selection of a core material for exact requirements.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the problem. But if an exact point can be determined, honeycombs offer the optimum solution in terms of weight and volume efficiency in many types of energy absorption problems.



World Service in Honeycombs

Executive Offices: 2050 Fourth Street, Delaney 10, Cal
Palo Alto, California and Delaney, Cal. Phone: 415-321-1000
Sales Offices: Long Island City, N.Y., Port Waukegan, Illinois, Richmond, Calif.

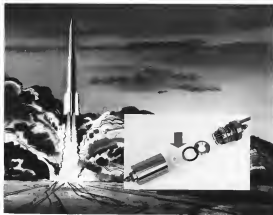
NAME	COMPANY	MILLIONS OF DOLLARS
1	Walter M. Smith Corp.	2.1
2	Walter M. Smith Corp.	1.4
3	Walter M. Smith Corp.	1.4
4	Walter M. Smith Corp.	1.4
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99	Walter M. Smith Corp.	1.4
100	Walter M. Smith Corp.	1.4

GLADHAND, DOUBLEDRY, GIRTH AND MARKUP IN ELECTROLAND!



FOOTNOTES

1. The right of use government-owned data, copyright, trademark and other rights are reserved. The data herein shall not be used for commercial purposes of \$10,000 or more without written consent, which shall constitute a license for the use of it.



KEL-F[®] Plastic...proved reliability for tough pressure assignments

Skidding vibration, croaking acceleration, extreme temperature variance—these are factors Wizards Engineering Company, Pasadena, California, is working to solve differential pressure setups for corrosive media with the help of KEL-F based Halobutene-butadiene Polymers.

Used in systems, these probes measure the differential flow of highly sensitive media, such as red and white (among water and oxygen). The probe operates efficiently between 0°F and 160°F, with a sensitivity change of less than 1% for a 100% change in temperature. The Aquagages (series above) are made of KEL-F plastic and run by Glaco Chemical Corp., a subsidiary of Eaco Products Co., Whittier, California. The damping fluid is a KEL-F based liquid oil.

KEL-F Plastic was chosen because it is chemically inert, thermally stable, has high impact, tensile and compression strength, and zero moisture absorption. This unique combination of features, plus others such as easy moldability, makes KEL-F Plastic ideal for many uses in aircraft, rockets and missiles including: Ducts, L/Os lip seals, valve diaphragms, flow meters and fuel nozzles.

3M-F Mineral Oils, Waxes and Greases, too, have remarkable properties. They can include: Compressor lubricants, damping fluids, hydraulic and pump fluids, and bond cleaners.

For multiple performance characteristics, write today specifying areas of interest to: IM Chemical Division, Dept. EAW-76, St. Paul 8, Minnesota.

^a1993–1994 season; 1994–1995 season.

CHEMICAL DIVISION
MINNESOTA MINING AND MANUFACTURING COMPANY
... WHERE RESEARCH IS THE KEY TO TOMORROW



we bowed against so that the middle hinge was about 2 m lower than the rear end tip. The middle hinge was about half the portion of trailing edge member even though shown attached. The oilhead and aftload hinge had separated at the upper tail lower saddle. These birds had very little movement.

The vertical stabilizer failed in the left wall with the rudder attached (ref. 130) from its marriage. When the rudder separated from the aircraft the lower hinge failed in the wall. The air trailing edge (left) joint adjacent to the middle hinge was loose. It was being held in place by one hand and the joint showed very little wood failure.

Impact Factor

All other damage to the ascus was the result of impact forces. There was some evidence of deformation present in several of the glaucous points which had appeared with very little wind before. In other points which had failed in a similar manner, there was no evidence of any deformation. (It was noted that some of the glaucous points on anemone glaucous plants had depended entirely upon the strength of the plant to hold them.)

In view of the findings during this investigation and the fact that this Model 18 production ceased in 1956, the Board issued its investigation into Mosser Service Co.'s present production methods for the Model 18. The present control system, which was installed by Mosser Service Co. in 1956, maintains a steel inventory system to check off stock as it is received into the plant to ensure conformity to specifications. Quality control of all fabricated parts is maintained by visual inspection of each operation. In addition, a conformity report on each lot of parts has to be filed and stating the number of units inspected, the workmanship and conformance to the drawings. Further, each time the stock is made and whenever metal is impacted into the stock, the metal operator must be checked.

A pollster's

The primary infection that the wheel reflects likely occurred when the glue joint of the No. 2 car separated allowing the trailing end member of the right hand member to pull away from the wheel. The wheel was damaged, the axle was bent and the railroad began removing material. As the axle was bent downward and the train's direction between the accident was toward the left, the wheel was bent downward and the trailing end member was consequently composed in the coupling, being it damaged at its track point. It is probable that as the trainbuckle separated from the axle and the axle was bent downward, the trailing end member was attached to the accident member until the accident member also failed. The wheel was bent in the direction of the accident location from the wreckage of the

The immediate needs of the loss of the stabilizer was a violent sideways pitching of the aircraft, which broke the right wing apart downstream in two places. Following this the aircraft rolled rapidly to the right and the cockpit fell complete. The aircraft

NEW AIRBORNE
ROTORAC
STEPPING MOTOR
OFFERS



- High torque, low speed
- Instant starting-stopping
- Low cost

For remote switching, valve operation, indexing devices — whatever high torque - low speed combined with split-second starting and stopping is required — Arborel's new ROTORAC motor offers excellent performance at minimum cost.

A typical C-220 MOTORAC weighs only 10 cu. yds delivered 6-8 lb. per cu. yd. at 70 days old.

current draw less than 75 amp at 115 v input. **RUTORAC** thus provides a lightweight motor capable of handling minor electrical and hydraulic switching functions now performed by more expensive gear-driven, brake-equipped motors.

The **RUTORAC** motor is a three rotor assembly with a dynamically stable armature vibrating at a rate of 1320 cps when operated from a 115 v ac power source. The three rotor assembly comprises of a positive stroke and a return stroke. Energy from the power stroke is stored in a coil spring and is released gradually for output torque, although a small portion is stored in a pair of balanced weights and utilized for the return stroke of the armature. This full cycle takes place within each half of an ac cycle.

Output torque is transmitted from the couplant through a linkage



Standard error calculated for 31 years (1976-2006), $n = 31$. $df = 29$. Based on the regression for 1980, and 1990. Data is based on 1700 ± 1 and 400 ± 1 .

rapid-action, one-way, thermostatic output, and a very rapid start-up in all very rapid start-stop situations. Under very light loads, however, the inertia of clutch and compressor shaft is sufficient to cause positively sufficient rotary momentum. Under heavy loads, or with the addition of decelerating action, the motion is of a stopping type where full torque is delivered and compression is maintained for a substantial half of an on cycle. Because of this start-stop motion, the starting torque and the running torque at the motor are approximately equal.

Available for either 50 or 60 cps, cycle 115 v-w, the ROTTORCOP can be supplied with various motor performance, mounting provisions and output shaft configurations.

For further information, contact any of our offices. Write for our Request Bulletin, RS-24.



AIRBORNE ACCESSORIES CORPORATION
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The Richmond Arsenal was producing thousands of rockets for the Confederacy and experiments on their deadly missiles were still underway as late as 1865.

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then fell easily vertically to the ground.

The generally poor condition of glued wood joints throughout the aircraft appears to be a result of poor production techniques. Although a few joints were found sound, one was noted in wing which had failed. It is not believed to have been of such a degree as to cause separation, with little or no wood failure. The above practice of using glued butt joints without grooves in the adjacent is considered poor. In the later Model 25 and 26, the problem is increased because the fuselage and wings are completely covered with plywood and this surface acts as a gasket for the structure.

Similarly poor production techniques were noted in numerous other throughout the aircraft. Failure of nose production, overall had failed in the wing support as at the posterior of the wing support and the joint itself. The wing should if properly made, be the strongest part in a fabric structure and loads exceeding design strength of the part should be in a joint adjacent to the wing rather than through the wing itself.

Conclusions

The Board concludes that the slight structural failure resulted from the application of a glued wood joint. The Board further concludes that proper bonding between the wood and glue was not obtained during production because of improper techniques and material. It is also concluded that the design problem did not provide a sufficient margin of safety to guard against weakening of the structure over a prolonged period.

As a result of recommendations made by the Board to the representatives of the Federal Aviation Agency following this investigation, the latter issued an airworthiness directive to correct these deficiencies.

Probable Cause

The Board determines that the probable cause of this accident was an illegal load built before brought about by the application of an improperly glued wood joint.

By the Civil Aeronautics Board

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Chairman

Don Gentry

Vice Chairman

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Member

ALAN S. BRYN

Member

Supplementary Data

The Civil Aeronautics Board was notified of this accident shortly after it occurred on Sept. 7, 1959. An investigation was immediately initiated in accordance with Section 701(a) (7) of the Federal Aviation Act of 1958. Deputies ordered by the Board were taken to the Columbus Airport, Columbia, Pa., on Oct. 13, 1959, and in Knoxville, Tenn., on Oct. 15, 1959.

The Aircraft

N 4178, a Mooney M19C5L, serial number 318, was manufactured July, 1955. A production and flight test performed on April 30, 1956, and the aircraft found to be airworthy. It was classified in the standard category. A current certificate of airworthiness was in

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LETTERS

Photo Realism

This is an amazing magazine for people on systems, so let's be accurate in our introduction.

In the page 13 note in the article on the BP 103C (p. 74) you picture a 181 is to mention how a cosmic mission where the technicians were asked the plane the moment the engine is out in order to get at the owners. Yet, as the cockpit is a machine who looks like he is taking out the cabin a certain kind of maintenance. This is a poor attempt at humor and I think that the person who read the whole thing ought to go back to his magazine where he would be interested.

Remember, when a picture is passed in your magazine it is looked at by persons like myself who examine it as every little detail. We try to be general all emotions, which is the reason we put out the most fine magazine. (Is this, did you notice the "Sj Plot" because the 111)

(The man having the small [p. 37] was an escaped but was for 12 U. Wood, one of the pilots mentioned in the story. What we have stated Reader Labe was the soft cap worn by Lt Wood both here and in the photo of the airplane crash. Everyone Editor David A. Anderson who took the photo points out that Lt Wood had removed his hard hat on the way to the wreck area and that the picture was by no means good. Another Wood appreciates demanding readers such as Mr. Labe and is just as anxious on the same subject they ask — Ed.)

Pilot View on Safety

Let us add a kind "Amor" to the sons of grace of Richard D. Brautman's letter (AM [June 27, 1992] and thank you for the far and otherwise article by David H. Hoffmann on the same issue (p. 11) about the Sisters Five American pilots' "voluntaristic state. Right after a progressively more cooperative effort to help the Soviet government's real and idealized efforts to help the Soviet government's voluntaristic state. The pursuit of economic safety in flight requires considerable mutual respect and understanding. It also requires a climate which will produce courage, openness, mutual consideration, and eventual education of most operating in the field. The Soviet Union's current state of emergency of what Mr. Brautman calls "polity exposed and more culture."

Since every one entitled to be here from birth was engaged in the "combined and disorganized protest" described by Mr. Hoffman, I, for one, went to the meeting which produced the action by 111 Pan-American pilots with the sincere intention of trying to talk my fellow pilots out of the proposed demonstration. By the time all systems of protest and action had been explored I became convinced that the Eastern pilots had demonstrated good sense in the sense they had taken, and that no other action had been known to them at our time.

Advisory Board welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, *Frontier Work*, 120 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

is an "We all deserve hope that the "widest" smile which could be taken to heart is all quarters so that nothing like it will ever have to take place again.

The story has had ample coverage in the press and much on which, but I should like to call attention to a few points which have been overlooked or insufficiently emphasized.

1 We pilots do not believe that the Federal Aviation Agency Administration is against flight safety. We do believe that the great proportion of its staff are sincere, dedicated men whose efforts through the years have been and will be devoted to the safe

2 We pilots here view and children sailing at home let us to return from flight. It is a common thought that we are depicted as being apart regulations which will make me fly, some say.

3 The information has been created that route inspections are the only means FAA inspectors have opportunities to check our proficiency. Two times each year we are required to demonstrate our ability to fly and meet requirements by using the flight simulator.

5 When an FNA inspector reported an Enderb captain—squad first captain's corrupt judgment—in marriage he was to let the inspectors take the second captain's seat if he became a question of whether the captain was in control of the search for which he was responsible. For hundreds of years on the sea, and for more than a cen-

I hope that the foregoing points are free from the petty squabbling and name-calling Mr. Buchanan so rightly deplores. However, while some will surely agree in some at least

I hope that I have mentioned sufficient reasons and that current problems of all concerned with safety in flight can be reasonably well and collectively solved.

William Karmali, Curt
Pan American World Airways
New York, N. Y.

Sonic Fatigue Lab

The article, "Laboratory in Investigative Science: Polymers" continued on the job 4 page.

The line of Bill Barrack and Newman

gave significant contributions to DM/IM as the project and were responsible for the design of the system. Sanford L. Caswell of DM/IM's Washington office was DM/IM project manager for the technical/engineering stream and Gary Gouffé was project

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is a collector of one year's standing, and the second assistant is American.

With available in my basement (has
two technical readers) in rapid space
spc data I could literally do without my
eye are over the year rapidly
documented content.

Why I suggest one last thing: no more 'moaning' than a mosquito perhaps, which yet might please many others as well as myself!"

The regional director has since "let work" when combining my new satellite uniting or any such spare sign machine, and put in the exact date. To those using AW as reference it is a bit daunting to have to hunt elsewhere for that date when it could so easily be so on become relevant. That one thing came up my and all notation I have of AW. There are no more

OTTO G. BROWN
Eastford, N. H.

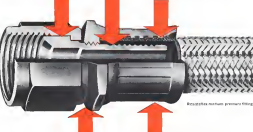
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